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THE
Deſcription and Uſe
Of Four ſeveral
QUADRANTS,
Two Great Ones, and Two Small Ones.

With the USE of A
Diagonal-Scale and Semicircle.

Each of them accommodated with LINES and CIRCLES, for the Reſolving of Propoſitions Inſtrumentally, In

CHRONOLOGY,	LONGIMETRIA,
ASTRONOMY,	NAVIGATION,
ALTIMETRIA,	DIALLING.

Invented and Written by the Ingenious Mr. JOHN COLLINS, *and Engrav'd by the Curious Hand of Mr.* HENRY SUTTON; *with Additions, not in the former Treatiſe, by* JOHN GOOD.

LONDON:

Printed for W. *and* J. MOUNT *and* T. PAGE, *in* Poſtern-Row *on* Tower-Hill. MDCCL.

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1750

TO THE READER.

Y*OU have in this following Treatiſe a Deſcription and Uſe of Four Mathematical Inſtruments, called* Quadrants: *Alſo a* Diagonal-Scale, *and a* Semicircle, *all invented by the Ingenious Mr.* JOHN COLLINS, *and Engrav'd by that unparallel'd Artiſt Mr.* HENRY SUTTON, *Mathematical-Inſtrument-Maker, their Uſes at large being firſt Publiſhed in the Year* 1659; *but the Book being now ſcarce and out of Print, I have, at the Requeſt of ſeveral Perſons Mathematically inclined, drawn from it the Uſefulleſt Parts thereof, I need not to ſay any thing in the Praiſe of theſe Inſtruments, becauſe they are already known to be the beſt of their kind that are extant, or (in my Opinion) ever will Hoping you will kindly accept of my Endeavours, tending to the Increaſe of Mathematical Knowledge, I remain a Well-wiſher to the* Mathematics.

JOHN GOOD.

A DESCRIPTION of the QUADRANT, Five Inches Radius.

Of the Lines on the Foreſide of the QUADRANT.

ON the Right Edge from the Center is placed a Line of equal Parts, of 5 Inches in Length, divided into 100 equal Parts.

On the Left Edge is a Line of Tangents continued to 63d. 26m.

Theſe Two Lines make a Right-angle in the Center, and between them include the Projection.

Next above this Projection towards the Center, is put on in the Quadrant of a Circle the Sun's Declination.

And above that, are four other Quadrants or Circles, containing the Days of the Month, reſpecting the Four Seaſons of the Year.

Underneath the Projection, towards the Limb, is put on, in one Half of a Quadrant, one of the Sides of a Geometrical Quadrant, and in the other Half the Line of Shadows.

Likewiſe, on the very Edge of the Quadrant, two Dialling-Scales, which do not proceed from the Center; that on the Right Edge is called the Line of Latitudes; and that on the Left Edge is the Scale of Hours proportionable to the Line of Latitudes.

There are belonging to this Quadrant two Horizons, and two Ecliptics; all meeting in one Point on the Left Edge of the Quadrant, *viz.* in the Tangent of 51 Deg. 30 Min. The firſt Horizon paſſeth from the aforeſaid Point to the Tropic of *Capricorn*, and marked with 100, 110, 120, 0: The ſecond Horizon paſſeth from the aforeſaid Point to the Tropic of *Cancer*, and marked with 10, 20, 30, 40: The firſt or Winter Ecliptic paſſeth from the aforeſaid Point to the Tropic of *Capricorn*, and marked thus with the Six Southern Signs; *Viz.* ♎—♓♏—♒♐—♑: The ſecond or Summer Ecliptic paſſeth from the aforeſaid Point to the Tropic of *Cancer*, and marked with the Six Northern Signs, *viz.* ♈—♍♉—♌♊—♋.

The Parallels of Altitude are thoſe Circles that ſeem Concentric, or Parallel to the firſt Horizon, and numbred from thence 62 Degrees (the Sun's greateſt Meridian Altitude in our Latitude) every fifth Degree thus .... and every tenth Degree drawn with a thicker Stroke thus —— which is diſtinguiſhable from the reſt. *Note,* Thoſe Parallels above the upper, or firſt Horizon, muſt be reckoned from the upper or firſt Horizon towards the Center; they are in Number 18.

The *Azimuth* are Circles croſſing the Parallels of Altitude, and numbered by 10, 20, 30, *&c.* from the Right Edge or Meridian.

Of the Lines on the Backſide of the QUADRANT.

1. On the Right Edge there is a Line of Signs iſſuing from the Centre, the Radius whereof is in Length 5 Inches.

2. On the Left Edge there is a Line of Chords iſſuing from the Centre.

3. On the Edge of the Quadrant there are two Scales for finding the Hour and Azimuth in one Latitude: The Hour-Scale is nothing but 62 Degrees of a Line of Signs, whoſe Radius is made equal to half the Secant of the Latitude (being fitted for *London*) to the common Radius of the Signs; the pricked Lines of Declination being annexed to it, and alſo continued beyond the other End of it to the Sun's greateſt Declination, is alſo a Portion of a Line of Signs, the Radius whereof is equal to the Sign of the Latitude taken out of the other Part of the Scale; or, which is all one, the Sign of the Sun's greateſt Declination is made equal to the Sign of its greateſt Altitude at the Hour of 6, taken out of the other Part of the Scale, which at *London* is 18 Degrees 12 Min.

4. The Azimuth-Scale is 62 Deg. of a Line of Sines, whoſe Radius is made equal to half the Tangent of the Latitude to the common Radius of the Signs, the Line of Declination annexed to it, and continued beyond it. To the Sun's greateſt Declination is alſo a Portion of the Line of Signs of ſuch a Length whereof the Sign of the Latitude is equal to the Radius of the Sign of the other Part of this fitted Scale; or which is all one, the Length of the Sun's greateſt Declination is made equal to the Sun's Vertical Altitude, which in this Latitude is 30 deg. 39 min. of the other Sign, or Line of Altitudes.

The Limb is numbred both with Degrees and Time, from the Right Edge towards the Left.

Between the Limb and the Centre are put on in Circles theſe Scales following.

I. A Line of Verſed Sines to 180 deg.

II. A Line of double Tangents, or Scale of Hours, being the ſame Dialling-Scale as was deſcribed on the Foreſide.

III. A Line of Verſed Sines of 90 deg.

IV. A Line of Secants to 60 deg. The Graduations thereof begin againſt 30 deg. in the Limb; to ſupply which Vacancy, and for other good Uſes, there is put on a Line of Signs to 90 deg. ending where the former Graduations begin. This is called the leſſer Signs.

V. A Line of Tangents graduated to 63 deg. 26 min.

VI. A Line of Tangents to 45 deg. or three Hours, through the whole Limb for Dialling, which may alſo be numbred by the Ark doubled to ſerve for a Projecting Tangent, *alias* a Semi-Tangent.

VII. In another Quadrant of a Circle may be inſcribed a Portion of a Verſed Sign to Eight times the Radius increaſed, of that 180 deg. called the Occupied Verſed Sign; and at the End of this from the other Edge, another Portion of a Verſed Sine to 12 times the Radius increaſed, may be put on.

VIII. And laſtly, above all theſe is the Scale of Hours, or Nocturnal, with Stars Names graved with it, towards the Centre. This is divided into 12 equal Hours, and their Parts; and the Stars are put on from their Rigt Aſcenſions, only with their Declinations figured againſt them.

The Uſe of the QUADRANT.

Sect. I. *Of the* ALMANACK.

BEFORE the *Projection* or *Quadrant* can be uſed, the Day of the Month, the Sun's Place in the Ecliptic, or the Declination of the Sun muſt be known. Now by this Almanack you may find the Day of the Month as well as by any common Almanack whatſoever.

It conſiſts of a rectangular Oblong, or long Square, divided into Seven Columns in Breadth, to repreſent the Seven Days of the Week, accounting *Sunday* the firſt; and Length ways into Nine Columns; the two uppermoſt repreſent the Months of the Year, accounting *March* the firſt; the five middlemoſt the reſpective Days of each Month; and the two undermoſt ſome certain Leap-Years, poſited in ſuch Columns, as that thereby may be known by Inſpection what Day of the Week the firſt of *March* happened upon in the ſaid Leap-Years paſt: Therefore, for your better Inſtruction, take this following Rule.

Firſt, having March *aſſign'd, to lead the Round*
The reſt o'th' Months are eaſ'ly after found:
If that you take the Complement in Days,
To 35 *of a placed Month always,*
And count it from its Place with due Progreſſion,
It ſhews you where the next Month takes Poſſeſſion.

1	6	3	8	2	7	4
9	0	11	0	5	10	12
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
27	23	24	25	26	27	28
29	30	31	0	0	0	0
68	80	64	76	60	72	56
96	8	92	4	88	700	84

Thus placing the Month of *March* firſt, then if you would place *April*, or the ſecond Month, *March* having 31 Days, the Complement thereof to 35 is 4; then counting four Columns from the Place of *March*, it falls upon the fifth Column, where the Figure 2 is placed for two Months; then *April* being placed, if you would place *May*, you muſt take 30, the Number of Days in *April*, from 35, and there reſts 5; and counting 5 Columns from the Place of *April*, which is in the third Column, the Figure 3 is placed for the third Month, or Month of *May*.

The next Thing to be known is, on what Day of the Week the firſt of *March* falleth upon, which is continually to be remembred in the enſuing Almanack; And,

This for ſome Leap-years paſt and to come may be known by accounting in what Column the ſaid Leap-Year is placed: But the Time preſent not agreeing with the Numbers in the Almanack, and the ſooneſt of the Time to come being 1756, I ſhall ſay nothing of it; but for a general Rule take it in theſe Words:

To the Number Two add the Year of our Lord, and a fourth Part thereof, neglecting the odd Remainder when there is any; the Sum divide by 7, the Remainder, when the Diviſion is finiſhed, ſhews the Number of Direction, or the Day of the Week on which the firſt of *March* falleth, accounting *Sunday* the firſt: but if nothing remains, it falls on *Saturday*.

2
Example for the Year 1709
The even Fourth 427
7) 2138 (305 is the Quotient.
3 Remaining.

By this Rule there will be found to remain 3 for the Year 1709, whence it follows that the firſt of *March* falleth on the third Day of the Week, *viz.* on *Tueſday* in this Year. So in the Year 1710 there will remain 4, for *Wedneſday*. In the Year 1711 there will reſt 5, for *Thurſday*. In the Year 1712 there will remain 0, for *Saturday*. In the Year 1713 there will remain 1, for *Sunday*. So that hence it may be obſerved that every fourth Year the firſt of *March* proceeds Five Days; upon which Suppoſition the former Rule is built. Say then, As 4 to 5, or as 1 to 1¼, ſo is the Year propounded to the Number of Days the firſt of *March* hath proceeded in all that Tract, cauſed by the odd Days in each Year, and the Acceſs of the Days for the Leap-Years. This Number divided by 7, the Remainder ſhews the fractinate Part of a Week above whole ones, which the ſaid Day hath proceeded, which will not agree with the Day of the Week it falls upon according to the common Tradition, unleſs the Number 2 be added thereto; which argues, that the firſt of *March*, as now we account the Days of the Week, fell upon *Monday*, or the ſecond Day of the Week in the Year of our LORD's Nativity. This is only for Illuſtration, of the former Rule, being to ſhew, That the adding of the even fourth Part of the Year of our LORD thereto, works the Proportion of 4 to 5.

The Uſe of this Almanack *is to know for ever on what Day of the Week any Day of the Month falleth upon.*

Remembring what Day the firſt of *March* fell upon in the Year propounded, (which doth then begin in the Uſe of this *Almanack*, and not ſooner or later, as upon *New-year's Day* or *Quarter-day)* all the Figures repreſenting the Days of the Month, do alſo repreſent the ſame Day of the Week in the Months under which they ſtand; and the Converſe, the Month being aſſigned, all the Figures that ſtand as Days under it inform you what Day of the ſaid Month the Week-Day ſhall be the ſame as it was upon the 1ſt Day of *March*; and then by the due Progreſſion, it will be eaſy to find upon what Day of the Month any Day of the Week falleth, as well as by any common *Almanack* whatſoever, without the trouble of one; and ſometimes two Dominical Letters quite ſhunned in this *Almanack* by beginning the Year the 1ſt of *March*; and ſo the odd Day for Leap-Year is introduced between the End of the Old and the Beginning of the New-Year.

In the Year 1709, looking for the Figure 10 in the Month-Column for the Month of *December*, under it I find 6, 13, 20, and 27. Now the firſt of *March* being *Tueſday*, I conclude alſo that theſe reſpective Days in *December* were likewiſe upon *Tueſdays*, and from hence collect that *Chriſtmas-day*, which is always the 25th of that Month, happened on a *Sunday*.

Sect. 2. *To rectify the* Bead.

BEFORE this *Projection* can be uſed, the Bead muſt be rectified: To do which, firſt, Lay the Thread over the Day of the Month in it is proper Circle; and if it be Summer wherein the Quadrant is to be uſed, ſet the Bead to the lower or Summer Ecliptic, and the Bead is fitted for Uſe; but if it be Winter, let it be ſet to the upper or Winter Ecliptic, and then it is alſo fitted for Uſe. But one Caution is yet to be given in rectifying the Bead; and that is, in Summer-time if it be required to find the Hour and Azimuth of the Sun by the *Projection*, before the Hour of 6 in the Morning, or after the Hour of 6 in the Evening, or (which is all one) when the Sun hath leſs Altitude than he hath at

6 of the Clock; then muſt the Bead be rectified to the Winter Ecliptic, and the Parallels above the upper Horizon are thoſe that will come in Uſe.

Sect. 3. *To find the Sun's Declination.*

HAVING by the foregoing *Almanack*, or by any other common *Almanack*, found the Day of the Month, the Thread laid over the ſame Day of the Month, it interſects it upon that Circle whereon it is graduated, which in the Summer Half-year is to be accounted on this Side the Equinoctial *North*, and in the Winter Half-year *South*. So laying the Thread over the 27th Day of *April*, it interſects the Circle of Declination at 17 Deg. and ſo much was the Sun's Declination.

Sect. 4. *To find the* Sun's *true Place.*

THE Thread lying as before, ſhews on the reſpective Ecliptic; ſo the Thread lying over the 27th of *April*, will cut the Summer Ecliptic in 17 deg. 7 min. of *Taurus*, or in 12 deg. 53 min. of *Leo*; which agrees to the 26th Day of *July*, the Thread interſecting both theſe Days at once; and the oppoſite Point of the Ecliptic hereto are 17 deg. 7 min. in *Scorpio*, about the 30th of *October*; and 12 deg. 53 min. of *Aquarius*, about the 22d of *January*, all ſhewed at once by the Thread's Poſition.

Sect. 5. *To find the* Sun's *Right Aſcenſion.*

LAY the Thread over the Day of the Month as before, and it interſects it in the equal Limb; whence taking it in Degrees and Minutes of the Equinoctial, whilſt the Sun is departing from the Equinoctial towards the Tropics, it muſt be counted as the Graduation of the Limb, from the Left Edge towards the Right; but when the Sun is returning from the Right Edge towards the Left, the Right Aſcenſion thus found muſt be eſtimated according to the Seaſon of the Year.

From	*June* 11. to *Sep.* 13.	it muſt have	90	Degrees added to it.
	Sept. 13. to *Dec.* 11.		180	
	Dec. 11. to *Mar.* 10.		270	

But in finding the Hour of the Night by the Quadrant, we need no more than 12 Hours of Aſcenſion for either Sun or Star; and the Limb is accordingly numbred from the Left Edge towards the Right from 1 to 6, and then back again to 12; and the other Figures are the Complement of theſe to 12: So that when the Sun is departing from the Equinoctial towards the Tropics, his Right Aſcenſion is (always) leſs than Six Hours, and the Complement of it more; but when he is returning from the Tropics towards the Equinoctial, it is always more than 6 Hours, and the Complement of it leſs. The odd Minutes are to be taken from the Limb, where each Degree being divided into 4 Parts, each Part ſignifies a Minute of Time: and to know whether the Sun doth depart from, or return to the Equinoctial, is very viſible by the Progreſſion and Regreſs of the Days of the Month, as they are denominated on the Quadrant.

Examp. So the Thread laid over 17 deg. of Declination, will be about

			d.	m.		h.	m.
The	27 *April*	the Sun's right Aſcenſion will be	44	37	In time	2	58
	26 *July*		135	23		9	2
	30 *October*		224	37		2	58
	22 *January*		315	23		9	2

But here the latter 12 Hours are omitted.

Sect. 6. *How to find the* Sun's *Amplitude, or Coaſt of Riſing and Setting from the true* Eaſt *to the* Weſt.

THE Bead being rectified as before, and brought to either of the Ecliptics, it matters not which, to either of the Horizons, the Thread will interſect the Amplitude ſought upon both alike. *Example :* The Sun's Declination being 17 deg. of North or South Declination, his Amplitude will be found to be 28 deg. 2 min.

Note, The Amplitude in the Summer Half-year is to be accounted from the Eaſt or Weſt Northwards: but in the Winter Half-year from thence Southwards.

Sect. 7. *To find the Time of the* Sun's *Riſing or Setting*.

THE Thread lying in the ſame Poſition as in the former Section, interſects the Aſcenſional Difference in the Limb, which may be there counted either in Degrees or Time.

So the Bead lying upon the Horizon, being rectified to 17 deg. of Declination, the Thread interſects the Limb at 22 deg. 38 min. which is 1 hour 3 min. of Time, and ſo it ſhews the time of Sun-riſing in Summer, or Sun-ſetting in Winter, to be half an hour paſt 4; and his riſing in Winter, and ſetting in Summer, to be half an hour paſt 7.

Sect. 8. *To find the Length of the* Day *or* Night.

THE time of the Sun's Riſing and Setting are one of them the Complement of the other to 12 Hours; ſo that one of them being known, the other will be found by Subtraction. The time of Sun-ſetting is equal to Half the Length of the Day; and it being doubled gives the whole Length of the Day; in reference of the Sun's abode above the Horizon, the time of ſetting converted into Degrees, is called the *Semi-diurnal Ark*; and the time of Sun-riſing ſo converted, is the *Semi-nocturnal Ark*, doubled, gives the whole Length of the Night. So on the 27th of *April*, the Sun having 17 deg. of Declination, the Length of the Day is 15 Hours, and the Length of the Night 9.

Sect. 9. *How to take the* Sun's *Altitude by the* QUADRANT.

TO take the Altitude of the Sun, you muſt take the Quadrant in both your Hands, laying your Right-hand ſomewhat near that Side that hath the Sights, and your Left-hand towards the other Side, by which you may let it ſlip lower, or raiſe it higher, as Occaſion requires. Then turning the Left Side of your Body to the Sun, move the Quadrant up or down till the Sun-beams do paſs through both the Sights at once, and the Thread hanging at full Liberty, ſhews it in the equal Limb, numbring them from that Side you hold in your Left-hand.

Sect. 10. *How to find the* Hour *of the* Day, *and the* Sun's *Azimuth at any time of the Year: And firſt in Winter.*

RECTIFY the Bead to the Winter Ecliptic, and carry it along the Parallels of Altitude, till it cuts or interſects that Parallel of Altitude on which the Sun was obſerved: and the Thread in the Limb ſheweth the Hour of the Day, and the Bead amongſt the Azimuths ſheweth the Azimuth of the Sun.

Example. So about the 18th of *Octob.* when the Sun hath 13 deg. 20 min. of S. Declination, if his obſerved Altitude of the Sun were 18 deg. the true Hour of the Day would be found to be either 36 min. after 9, or 24 min. paſt 2: and his Azimuth would be 37 deg. from the *South*, Eaſtwards in the Forenoon, but Weſtwards in the Afternoon.

Sect. 11. *How to find the* Hour *of the* Day, *and the* Sun's *Azimuth, in the Summer Half-year.*

AS I before intimated, That if the Queſtion were, When the Sun hath leſs Altitude than he hath at 6 of the Clock? then the Operation muſt be performed amongſt thoſe Parallels above the upper Horizon, in the reverted Tail, the Bead being rectified to the Winter Ecliptic.

Prob. I. But firſt I ſhall ſhew you, *to find what Altitude the Sun will have at 6 of the Clock in the Summer Half-year.*

This will be eaſily performed by bringing the Bead that is rectified to the Summer Ecliptic on the Left Edge of the Quadrant; and there, amongſt the Parallels of Altitude it ſheweth what Altitude the Sun will have at 6 of the Clock. *Example.* So when the Sun hath 17 deg. of *North* Declination, which is about the 27th of *April*, his Altitude at 6 of the Clock will be found to be 13 deg. 14 min. and his Azimuth from the Meridian 100 deg. 30 min. whence I may conclude, if his obſerved Altitude be leſs upon the ſame Day, and the Hour and Azimuth required, the Bead may ſet to the Winter Ecliptic, and the Operation performed in the reverted Tail.

Prob. II. *To find the Hour of the Day, and the Azimuth of the Sun, when his Altitude is leſs than it is at the Hour of* 6.

Admit, the 24th of *April* the Sun's obſerved Altitude were 7 deg. Lay the Thread over the Day of the Month, and rectify the Bead to the Winter Ecliptic, then bring it to the Parallel of Altitude above the upper Horizon; the Thread interſects the Limb at 9 deg. 3 min. ſhewing the Hour of the Day to be 24 min. paſt 5 in the Morning, or 36 min. paſt 6 in the Evening; and the Bead among the Azimuths, ſhews the Azimuth to be 107 deg. from the *South* Northwards.

Prob. III. *To find the Hour of the Day, and Azimuth of the Sun, when his Altitude is more than it is at the Hour of* 6.

But admitting the Sun to have more Altitude than he hath at the Hour of 6, the Operation notwithſtanding differs not from the former *Problem*, but only in rectifying the Bead, which muſt be ſet to the Summer Ecliptic, and then carried to the Parallel of the Sun's obſerved Altitude, and the Thread will interſect the Limb at the true Hour of the Day, and the Bead amongſt the Azimuths ſhews the Coaſt, or Azimuth of the Sun. So upon the 24th of *April* the Sun's obſerved Altitude being 45 deg. I bring the Bead rectified to the Summer Ecliptic, to the ſaid Parallel of Altitude, and the Thread interſects the Limb at 55 deg. 15 min. ſhewing the Hour of the Day to be either 41 min. paſt 9 in the Morning, or 19 min. paſt 2 in the Afternoon; to be known which, by the increaſing or decreaſing of the Altitude; and the Bead amongſt the Azimuths, ſheweth the Azimuth or true Courſe of the Sun to be 50 deg. 41 min. from the *South*.

Prob. IV. Admit when the Sun hath 19 deg. 13 min. North Declination, which is about the 6th of *May*, his obſerved Altitude were 56 deg. the Bead being ſet to the Summer Ecliptic, and brought to that Parallel, the Bead amongſt the Azimuths ſhews the Sun's true Courſe or Azimuth to be 23 deg. Eaſtwards in the Forenoon, and Weſtward in the Afternoon; and the Thread in the Limb ſheweth the true time of the Day to be either 7 min. paſt 11 in the Forenoon, or 53 min. paſt 12.

Sect. 12. *How to find the Sun's Altitude on all Hours, or at any Time propoſed.*

IN Summer-time, if the Hour propoſed be before 6 in the Morning, or after it in the Evening, lay the Thread to the Hour in the Limb, the Bead being firſt rectified to the Winter Ecliptic, and amongſt the Parallels of Aititude above the upper Horizon, it ſheweth the Altitude ſought.

Example. The Sun having 16 deg. of Declination Northwards, as about the 24th of *April*, Lay the Thread over the Day of the Month, or the Declination 16 deg. ſetting the Bead to the Winter Ecliptic; and if it were required to find what Altitude the Sun ſhall have at 36 min. paſt 6 in the Afternoon, Lay the Thread over the ſame in the Limb, and the Bead amongſt the Parallels of Altitude will fall upon 7 deg.

At all other times the Operation is alike: The Bead being rectified to that Ecliptic that is proper to the Seaſon of the Year, lay the Thread over the propoſed Hour in the Limb, and the Bead amongſt the Parallels of Altitude ſheweth the Altitude ſought.

Example. So if it were required the ſame Day to find what Altitude the Sun ſhould have at 19 min. paſt 2 in the Afternoon, lay the Thread in the Limb over the Time given, and the Bead amongſt the Parallels of Altitude will fall upon 45 deg. for the Altitude ſought.

Sect. 13. *To find the Sun's Altitude on all Azimuths.*

IN the Summer Half-year, if the Azimuth propounded be more Northward than the Azimuth the Sun ſhall have at the Hour of 6, the Bead muſt be rectified to the Winter Ecliptic, and brought to the Azimuth propoſed above the upper Horizon, and there among the Parallels of Altitude it ſheweth the Altitude ſought.

So about the 24th of *April*, when the Sun's Declination is 16 deg. his Azimuth at 6 of the Clock will be found to be 100 deg. 10 min. from the *South*; then if it were required to find the Sun's Altitude upon an Azimuth more remote, as upon 107 deg. 45 min. from the *South*, laying the Thread over the Declination. I ſet the Bead to the Winter Ecliptic, and afterwards carrying it to the Azimuth propoſed among the Parallels of Altitude above the upper Horizon,

rizon, it falleth upon 7 deg. for the Sun's Altitude. In all other Caſes bring the Bead (rectified to the Ecliptic proper to the Seaſon of the Year) to the Azimuth propoſed; and among the Parallels of Altitude it ſheweth the Altitude ſought.

So upon the ſame Day I ſet the Bead to the Summer Ecliptic, and if it were required to know what Altitude the Sun ſhall have when his Azimuth is 50 deg. 48 min. from the Meridian, carry the Bead to the ſaid Azimuth, and among the Parallels of Altitude it will fall upon 45 deg. for the Altitude ſought.

Sect. 14. *Of the Stars graduated on the Projection.*

SUCH Stars as are between the two Tropics only, are there inſcribed, and have many Things common in their Motions with the Sun, when he hath the like Declination; as, the ſame *Amplitude*, *Semidiurnal-Arch*, *Meridian*, *Altitude*, *Aſcenſional Difference*, &c. Theſe Stars have Letters ſet to them, to direct to the Circle of Aſcenſions on the Back of the Quadrant, where the Quantity of their Right Aſcenſion is expreſſed from one of the Equinoctial Points: Thoſe that have more Aſcenſion than 12 Hours from the Point of *Aries*, are known by the Character *Plus* † ſet to them, many more Stars might be there inſerted; but if they have more than 25 deg. 30 min. of Declination, the Propoſitions to be wrought concerning them are to be performed with Compaſſes, by the general Lines on the Quadrant.

Prob. I. *To find the true Time of the Day or the Night when any Star cometh to the Meridian.*

In the Performance of this Propoſition, we muſt make Uſe of the Sun's whole Right Aſcenſion in Time, (which how it may be known hath been already treated of) as alſo of the Stars whole Right Aſcenſion, which may be had from the Circle of Aſcenſion on the Back-ſide of the Quadrant, if 12 Hours be added to the Right Aſcenſion of a Star taken thence, that hath a Letter or Character: Subtract the Sun's whole Right Aſcenſion from the Star's whole Right Aſcenſion, increaſed by 24 Hours when Subtraction cannot be made without it, the Remainder, if leſs than 12, ſheweth the Time of the Afternoon or Night when the Star will be upon the Meridian: But if there remain more than 12, reject 12 out of it, and the Reſidue ſhews the Time of the next Morning when the Star will be upon the Meridian.

Example. The 23d of *December* the Sun's whole Right Aſcenſion is 18 Hours 53 min. which ſubtracted from 4 Hours 16 min. the Right Aſcenſion of the *Bull's Eye*, increaſed by 24, there remains 9 Hours 43 min. for the Time of that Star's coming to the Meridian at Night.

This Propoſition is of good Uſe for Seamen, who have occaſion to obſerve the Latitude by the Meridian Altitude of a Star, that they may know when will be a fit Time for Obſervation. In finding the Time of the Night by the Stars, we uſe but 12 Hours of Right Aſcenſion, nor no more in finding the Time of their riſing or ſetting; ſo that when it is found, whether it be Morning or Evening, it is left to Judgment, and may be known by comparing it with the former Propoſition, if there be need ſo to do.

Prob. II. *To find the Declination of any of theſe Stars.*

This is annexed to the Stars Names; yet it may be found on the Projection, by rectifying the Bead to the propoſed Star, and bringing the Thread and

Bead to that Ecliptic it will interſect; and in the ſame Poſition the Thread will interſect the Star's Declination in the Quadrant of Declination: If the Bead meet with the Summer Ecliptic, the Declination is *North*; if with the Winter, *South*.

Prob. III. *To find the Amplitude and Aſcenſional Difference of any of the Stars on the Projection.*

Bring the Bead, rectified to the Star, to either of the Horizons, the Thread being kept in its due Extent: and where it interſects the ſame, it ſhews that Star's Amplitude, which varies not, and is Northward if the Star have North Declination, otherwiſe Southward; and the Thread likewiſe interſecting the Limb, ſheweth the Star's Aſcenſional Difference.

Example, So the Bead being rectify'd to the *Bull's-Eye*, and brought to the lower Horizon, ſhews the Amplitude of that Star to be 25 deg. 54 min. Northwards, becauſe the Star hath North Declination; and the Thread lieth over 20 deg. 49 min. of the Limb, which is the Star's Aſcenſional Difference, which is in Time 1 hour 23 min. The Thread in the Limb lieth over 4h. 37m. from Midnight for the Star's Hour of Riſing, and over 7h. 23m. from the Meridian for the Star's Hour of Setting always in this Latitude; which with the Amplitude varies not, except with a very ſmall Allowance in many Years.

Prob. IV. *To find a Star's Diurnal Ark, or time of its continuance above the Horizon.*

	North		add
When the Star hath		Declination,	
	South		ſubtract

The Aſcenſional Difference	to		Sum	
of the Star before found		6 hours, the		is half the Time,
in Time	from		Reſidue	

Of the Stars continuance above the Horizon, which doubled ſhews the whole Time, the Complement whereof to 24h. *is the Time of that Star's durance under the Horizon.*

Examp. So the Aſcenſional Difference of the *Bull's Eye* being in Time 1h. 23m. added to 6h. and the Sum doubled, makes 14h. 46m. for the Star's Diurnal Ark, or above the Horizon the Reſidue whereof from 24h. is 9h. 14m. for the Time of the Star's durance under the Horizon.

Prob. V. *To find the Time of the Day or Night, when the Star riſeth or ſetteth.*

The Stars hour of Riſing or Setting found as before, being no other but the Aſcenſional Difference of the Star added to, or ſubtracted from 6 hours which the Thread ſheweth in the Limb, the Bead being rectified to the Star and brought to that Horizon, it will interſect, is not the true Time of the Night; but by help thereof that may be come by. This I have denominated, to be the Star's Hour, and is no other but the Star's Horary Diſtance from the Meridian it was upon laſt.

If a	North	Declination, the Stars	before		and the	after	
Star		hour of riſing muſt be		6	time of		6
have	South	reckoned to be	after		ſetting	before	

Now the Time of the Star's Riſing or Setting, found by this and the former

Propoſition, muſt be turned into common Time by this Rule. To the Complement of the Sun's Aſcenſion add the Star's Aſcenſion, and the Star's Hour from the Meridian it was laſt upon; the Amount, if leſs than 12, ſhews the time of the Star's Riſing or Setting accordingly; but if it be more than 12, reject 12 as oft as may be, and the Remainder ſheweth it.

So upon the 23d of *December* for the Time of the *Bull's-Eye* Riſing,

	h.		m.
The Complement of the Sun's Aſcenſion found by the foreſide of the Quadrant, is		:	7.
And the Star's Aſcenſion on the backſide, is	4	:	16.
The Star's hour of Riſing, is	4	:	37.
	14 hours		

From which 12 rejected, reſts 2 hours for the Time of that Star's Riſing, which I conclude to be at 2 in the Afternoon, becauſe that Star was found to come to the Meridian at 23m. paſt 9 at Night. The like Operation muſt be uſed to get the Time of the Star's Setting, which will be found to be at 46 min. paſt 4 in the Morming.

	h.		m.
Complement of the Sun's Aſcenſion,	5	:	7.
Star's Aſcenſion,	4	:	16.
The Star's hour of Setting,	7	:	23.
	16	:	46.

Prob. VI. *To find what Altitude and Azimuth a Star that hath North Declination, ſhall have when it is 6 hours of Time from the Meridian.*

Rectify the Bead to the Star, and bring the Bead and Thread to the Left Edge of the Quadrant; and there, amongſt the Parallels of Altitude and Azimuth, it ſheweth what Altitude and Azimuth the Star ſhall have.

Example. So the Bead being ſet to the *Bull's-Eye*, and brought to the Left Edge of the Quadrant, it will be found to have 12d. 37m. of Altitude, and 8d. 3m. Azimuth, from the South, when it is 6 hours of Time from the Meridian, which Propoſition is afterwards uſed to know to which Ecliptic in ſome Caſes to rectify the Bead, as hath likewiſe been intimated before.

Prob. VII. *The Azimuth of a Star propoſed, to find what Time of the Night the Star ſhall be upon its Azimuth, and what Altitude it ſhall then have*

Suppoſe the Azimuth propoſed be nearer the South Meridian than the Azimuth the Star ſhall have when it is 6 hours from the Meridian: Bring the Bead, rectified to the Star, to the propoſed Azimuth, and among the Parallels of Altitude it ſhews the Star's Altitude; and the Thread in the Limb ſhews that Star's Hour to be turned into common Time, to attain the true Time ſought.

Example. If the Queſtion were what Altitude the *Bull's-Eye* ſhall have when his Azimuth is 62d. 48m. from the South? This being leſs Azimuth than he hath at 6 hours from the Meridian, the rectified Bead being brought to the Azimuth, ſheweth among the Parallels of Altitude to be 39d. and the Star's Hour ſhewn by the Thread in the Limb is either 8h. 56m. or 3h. 4m. from the Meridian: Then if upon the 23d of *Decemb.* you would know at what Time the Star ſhall have this Altitude on this Azimuth, change the Star's Hour into common Time by the former Rule.

December 23d.	Complement of Sun's Aſcenſion,	5 : 7	5 : 7
	Star's Aſcenſion,	4 : 16	4 : 16
	Star's Hour,	8 : 56	3 : 4
		18 : 19	12 : 27

And you will find it to be 19m. paſt 6 in the Evening, or 27m. paſt Midnight.

For Stars of *South* Declination, being they have no Altitude beyond the Horizon at 6 Hours Diſtance from the Meridian, the Operation will be the ſame, void of Caution: But for Stars of *North* Declination, when the propoſed Azimuth is more remote from the *South* Meridian, the Azimuth of that Star 6 Hours from the Meridian, another Bead muſt be rectified to the Winter Ecliptic, and carried to the Azimuth propoſed above the upper Horizon, where amongſt the Parallels, it ſhews the Altitude ſought, and the Thread in the Limb ſheweth the Stars Hour to be converted into common Time.

Example. The Azimuth of the *Bull's-Eye* being 107 deg. 53 min. from the *South*, which is more than the Azimuth of 6 Hours, the other Bead ſet to the Winter Ecliptic, and carried to that Azimuth in the Tail, ſhews the Altitude to be 6 deg. and the Star's Hour to be 5h. 18m. or 6h. 42 min. which converted into common Time, as upon the 23d of *December*, will be either 41 min. paſt 2 in the Afternoon, or 5 min. paſt 4 in the Morning following.

		h. m.	h. m.
December 23.	Complement Sun's Aſcenſion,	5 : 7	5 : 7
	Star's Aſcenſion,	4 : 16	4 : 16
	Star's Hour,	5 : 18	6 : 42
Rejecting 12, the Total is,		2 : 41 or	4 : 5

Prob. VIII. *The Hour of the Night propoſed, to find what Altitude and Azimuth any of the Stars on the Projection that are above the Horizon ſhall have at that Time.*

Firſt, Turn common Time into the Star's Hours. The Rule to do it is, To the Complement of the Star's Aſcenſion add the Sun's Aſcenſion, and the Time of the Night propoſed, the Aggregate, if leſs than 12, is the Star's Hour; If more, reject 12 as oft as may be, and the Remainder is the Star's Hour ſought.

So the 23d of *December* at 59 min. paſt 8 at Night, what ſhall be the horary Diſtance of the *Great Dog* from the Meridian?

	h.	m.
Complement of the *Great Dog's* Aſcenſion,	5 :	30
Sun's Aſcenſion,	6 :	53
Time of the Night	8 :	59
The Sum is, 12 rejected.	9 :	22

Then for the Stars of *South* Declination, rectify the Bead to the propoſed Star, and lay the Thread over the Star's Hour in the Limb, and the Bead amongſt the Parallels and Azimuth, ſhews the the Altitude and Azimuth ſought.

Examp. So the Bead being rectified to the *Great Dog*, and the Thread laid over 9h. 22m. in the Limb, the Bead will ſhew the Altitude of that Star at that Time of the Night to be 14 deg. and its Azimuth 39 deg. from the *South*.

The Operation is the ſame with Stars of *North* Declination, when the Star's Hour found as before is not more remote from the *South* Meridian than 6 Hours on either Side; But if it be more than 6 Hours Diſtance from the Meridian, as before 6 after its Riſing, or after it before its Setting, then, as before ſuggeſted, one Bead muſt be rectified to the Star, and brought to the Summer Ecliptic, where the Thread being duly extended, another muſt be ſet to the Winter Ecliptic, and afterwards the Thread laid over the Star's Hour in the Limb, this latter Bead will ſhew the Star's Azimuth and Parallel of Altitude in the reverted Tail above the upper Horizon.

Example. So upon the 23d of *December* I would know what Azimuth and Altitude the *Bull's-Eye* ſhall have at 5 min. paſt 4 in the Morning following.

	h.		m.
Time propoſed,	4	:	5
Complement of the *Bull's-Eye* Aſcenſion,	7	:	44
Sun's Aſcenſion 23d of *December*,	6	:	53
12 rejected, reſts	6	:	42

Proceed then, and lay the Thread over 42m. paſt 6, and the Bead, amongſt the other Parallels in the Tail, ſheweth the Star's Altitude to be 6 deg, and its Azimuth from the Meridian 107 deg. 53 min.

Theſe two Propoſitions have a good Tendency in them to diſcover ſuch Stars as are upon the Projection, if you know them not; But ſuppoſing them known, the Propoſition of chiefeſt Uſe is,

By having the Altitude of a Star given, to find out the true Time of the Night, and the Azimuth of that Star.

If the Star's obſerved Altitude be leſs than its Altitude at 6 Hours Diſtance from the Meridian, bring the Bead rectified to the Star, to the Summer Ecliptic, and ſet another Bead rectified to the Winter Ecliptic; then carry it to the Parallel of Altitude above the upper Horizon in the reverted Tail, and there it will ſhew the Azimuth of that Star: and the Thread in the Limb ſhews the Hour.

Examp. If the obſerved Altitude of the *Bull's-Eye* were 6 deg. its Azimuth will be found to be 107h. 53m. from the *South*, and its Hour 42m. paſt 6 from the Meridian, the true Time will be found to be 5m. paſt 4 in the Morning the 24th of *December*.

	h.		m.
Complement of the Sun's Aſcenſion, 23 *Decemb.*	5	:	7
Star's Hour,	6	:	42
Star's Aſcenſion,	4	:	16
	4	:	5

But for Stars that have *South* Declination or *North*, when their Altitude is more than their Altitude being 6 Hours from the Meridian, this Trouble of rectifying the two Beads is ſhunned; in this Caſe, only bring the Bead that is rectified to the Star, to the Parallel of Altitude, and there (amongſt the Azimuths) it will ſhew the Star's Azimuth, and the Thread in the Limb interſects the Star's Hour ſought.

Examp. Decemb. 11. The *Bull's-Eye*, Altitude 39 deg. Azimuth from the *South* 62h. 48m.

Hours

	h.	m.
Hours from the Meridian,	8	56
Complement of the Sun's Aſcenſion,	6	00
Aſcenſion of the *Bull's-Eye*,	4	6
	7	12

The true Time of the Night was 12m. paſt 7 a Clock.

Another Examp. Decemb. 31. The *Great Dog's* obſerved Altitude being 14 deg. his Azimuth from the South, will be 39 deg.

	h.	m.
And the Star's Hour from the Meridian,	9	22
The Complement of the Sun's Aſcenſion,	4	30
The Star's Aſcenſion,	6	30
	8	22

The true Time of the Night is 22 min. paſt 8 of the Clock.

Prob. IX. *Of the Quadrant of Aſcenſion, and how to turn the Star's Hour into common Time, called* the Sun's Hour.

Get the Diſtance between the Aſcenſion of the Sun and the Star, by ſubtracting the leſs from the greater; add the Remainder to the Stars Hour, when the Star is before, or hath more Aſcenſion than the Sun; but otherwiſe it muſt be ſubtracted from it, and the Sum or Remainder is the true Time ſought.

ALTIMETRA.

IS That that is ſubſervient or aſſiſtant to you in the Height of any Object, acceſſible or inacceſſible: That is called *Acceſſible* that is eaſy to come at, and that is *Inacceſſible* that is hard to come at, by Reaſon of a River, or ſome other Object in the way.

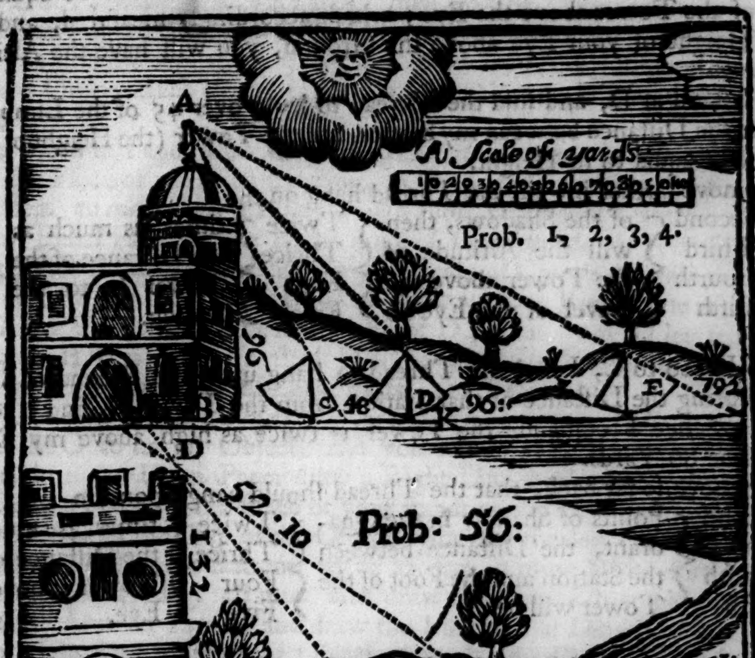
Of the Quadrant of Shadows.

BOTH theſe, as was ſhewed in the Deſcription of the *Quadrant*, are no other than a Table of Natural Tangents to the Arch of the Limb, and may ſupply the Uſe of ſuch a Canon, tho' not with ſo much Exactneſs. All the Parts of the Quadrant are to be eſtimated leſs than the Radius, till you come to 45 of the Limb, where is ſet the Figure 1, and afterwards among the Shadows is to be accounted more than the Radius;

			h.	m.	
And ſo where the Tangent is in Length	2	Radius, as againſt	63	26	of the Limb,
	3		71	34	
	4		75	58	
	5		78	42	

are ſet the Figures 2, 3. 4, 5: and becauſe they are of good Uſe to be repeated on the other ſide of the Radius in the Quadrant, there they are not figured, but have only Full-points ſet to them, falling againſt the like Arches of the Limb from the Right edge towards the Left, as they did in the Shadow from the Left towards the Right.

Prob.



Prob. I. *To find a Height at one Obſervation.*

LET AB repreſent the Tower whoſe Altitude you would take: Go ſo far back from it, that looking through the Sight of the Quadrant, the Thread may hang upon 45 deg. of the Limb, or upon 1, or the firſt Prick of the

Quadrant, and the Diſtance from the Foot of the Tower will be equal to the Height of the Tower above the Eye; which accordingly meaſured, and thereto add the Height of your Eye above the Ground, you will have the Altitude of the Tower.

So if I ſtand at D, and find the Thread to hang over 45 of the Limb, I may conclude the Diſtance between my Station and the Tower (the Height of my Eye added) to be equal to its Height.

If I remove farther in, till the Thread hang on the

Second	of the Shadows, then will the Altitude of the Tower above the Level of the Eye be	Twice	times as much as the Diſtance of the Tower is to the Statiou.
Third		Thrice	
Fourth		Four	
Fifth		Five	

Prob. II. So to C, I find the Thread to hang upon the Second of Shadows, and meaſuring the Diſtance of that Station from the Tower, I find it to be 48 Yards; whence I conclude the Tower is twice as high above my Eye, and that will be 96 Yards.

So I remove ſo far back, that the Thread ſhould hang upon the

Second	Points of Shadow in the Quadrant, the Diſtance between the Station and the Foot of the Tower will be	Twice	times as much as the Diſtance of the Tower above the Eye.
Third		Thrice	
Fourth		Four	
Fifth		Five	

Example. Prob. III. Suppoſe I ſtand at E, and looking through the Sights of my Quadrant, the Thread falling at the ſecond Point of Shadow in the Quadrant, then I conclude the Diſtance from the Foot of the Object to the Place of my ſtanding to be twice the Height of the Object which I meaſure, and find it to be 192; half whereof, being 69, is the Tower's Height.

Prob. IV. *Another Way, by the Quadrant, that is numbred from the Left Edge towards the Right with* 1, 2, 3, 4, 5, 6, 7, *and ſo on.*

With any Dimenſions whatſoever of a competent Length, meaſure off from the Foot of the Object, juſt 10, or 100, *&c.* of the ſaid Dimenſions; As, ſuppoſe from B to K, I meaſure off 100 Yards, looking through the Sights of my Quadrant, to the Top of the Object at A; and what Part the Thread hangs on in the Quadrant or Shadows, ſhews the Altitude of the Object in the ſaid meaſured Parts; and ſo at the Station at K, the Thread will hang on 96 Parts, ſhewing the Altitude of the Object AB to be 69 Yards above the Eye.

Prob. V. *A general Way at Random.*

At any Diſtance unknown, I look through the Sights of my Quadrant, and I find the Thread to cut in the Limb of the Quadrant 40 deg. the Proportion holds.

As the Radius 90	10.00000
Is to the Diſtance meaſured 84 Yards	1.92428
So is the Tangent of the Angle 40 deg.	9.92381
To the Height of the Object 70 Yards	21.84809

Prob. VI. *Of an Altitude inacceſſible, or which cannot eaſily be come at.*

Suppoſe DE to be an Object, and you ſtanding at G, were required to know the Height, but by reaſon of ſome River or Mote, you cannot come to meaſure from G to E: In this Caſe, firſt meaſure from G towards E, as far you can come to, as at F, which is at 83 Yards; then making Obſervations at G, you find the Thread to cut the Limb of the Quadrant in 35 deg. 50 min. and obſerving at F, you find the deg. to be 51d. 0m. Now from this Diſtance meaſured, and the two Obſervations by the Quadrant, the Altitude DE may be obtained in this manner.

Upon a Piece of Paper draw the Line HK at pleaſure, in which aſſume a Point for the Place of your firſt ſtanding, as G, and protracting the Angle obſerved 35 deg. 50 min. draw a Line through thoſe Degrees at Liberty; then by the Scale of Equal Parts on the Right Edge of the Foreſide of your Quadrant, lay off 83 Yards from G to F, then by your Scale of Chords protract the Angle at B, 51d. 0m. and thro' thoſe Degrees draw another Right Line at pleaſure, which will cut the former Line in the Point D; then from D let fall a Perpendicular to HK as DF, ſo ſhall DE be the true Height of the Object meaſured from the ſame Line of Equal Parts, 132 Yards.

Prob. VII. *How to take the Height of an Object ſtanding on a Hill, inacceſſible.*

Suppoſe MO to be an Object, and you ſtanding at L were required to find its Height: 1. Upon Paper draw a Right Line at pleaſure, as QR, and therein aſſume a Point for the Place of your ſtanding, as L, where, with your Quadrant directed to the Top of the Object, you find the deg. cut to be 37 deg. 40 min. and directed to the Bottom, to be 14 deg. 0 min. Wherefore upon L, protract the Angle 37 deg. 40 min. and draw the Line Lb at pleaſure; alſo upon the ſame Arch ſet 14 deg. and draw the Line Lc at Length. 2. Go forwards in a Right Line towards the Object, from L (the Place of your ſtanding) to N 92 Yards, it being as nigh as you can come to it for the River; and there, with your Quadrant directed to the Top of the Object, as M, you find the d. cut to be 49 deg. 30 min. alſo at the Bottom the deg. to be 29d. 30m. Then go again to your Paper, and from L to N meaſure off 92 Yards or Parts from your Quadrant, and in N protract both the Angles laſt found, namely 49d. 30m. and 29d. 30m. and through the two Points draw Lines at Length, at Na, cutting the Line Lb in M, and Nd cutting the Line Lc in O. *Laſtly*, to find its Height, let fall from M, the Top, a Perpendicular MP, that Line cutting the Line QR, is the Height of the Object and the Hill together, which will be 100 Yards. Now obſerve where the Line Lc and the Line Nd croſs each other, which is in the Point O, the Bottom of the Object, which being meaſured from O the Bottom, to M the Top, will be found to be 45 Yards, which is the Height required.

Of LONGEMETRIA.

How ſtanding upon an Object of a known Height, to find the Diſtance from thence to ſome other remote Object.

Suppoſe DE, Fig. 2. to be the Side of a Fort or Bulwark, 132 Yards high, being at the Top, D, you ſee a Tree or other Object, as the Windmill at A, whoſe Diſtance you would know from the Foot of the Wall at E. Therefore, being at the Top, D, and looking thro' the Sights of my Quadrant to the Mill at G, I obſerve the Thread to hang on 54 deg. 10 min. numbred from the Right Edge. Now to find the Diſtance, draw on Papet the Line DE, and from D to E, I ſet off 132 Yards, and in E I raiſe a Perpendicular EK, then in the Point D, protract the Angle 52 deg. 10 min. and draw the Line from the Point D, till it touch the Line EK: So is EK meaſured on your Scale of Equal Parts, the Diſtance required, 188 Yards.

THE
DESCRIPTION and USES
OF A
Great Univerſal QUADRANT,
Eleven Inches RADIUS.

The DESCRIPTION *of the Fore-ſide.*

ON the Right Edge from the Center is plac'd a Line of Sines.

On the Left Edge from the Center a Line of Sines to 180.

The Limb is the ſame as in the ſmall Quadrant before-going.

Between the Limb and the Center are plac'd, in Circles, a Line of Verſed-Sines to 180, another through the whole Quadrant's Limb to 90.

Then a Line of leſſer Sines and Secants.

The Line of Tangents.

The Quadrant and Shadows.

Above them the Projection, with the Declinations, Days of the Month and Almanack.

On the Left Edge is plac'd the fitted Hour and Azimuth Scale.

Within the Projection, abutting againſt the Sines, is placed a little Scale, called the Scale of Entrance, being graduated to 62 Deg. and is no other but a Line of Sines number'd by the Complement.

At the End of the Secant is put on the Verſed Sine doubled, that is, to twice the Radius of the Quadrant, and at the End of the Tangents tripled to ſome few Deg. to give the Hour and Azimuth, near Noon, more exactly.

On the Backſide of the Quadrant.

On the Right Edge from the Center is placed a Line of Equal Parts, being 10 Inches preciſe, decimally ſubdivided.

On the out-ſide, next the Edge, is placed a large Chord to 60, equal to the Length of the Radius of the Line of Sines.

On the Left Edge is placed a Line of Tangents iſſuing from the Center, continued to 63 deg. 26 min. and again continued apart from 60d. to 75 deg.

Next, the equal Limb.

Within it a Quadrant of Aſcenſion, divided into 24 equal Hours, and their Parts, with the Star's affix'd, and the Letters grav'd, to refer them to Names.

Between it and the Center is placed a Circle, whereof there are but three Quadrants graduated.

The Diameter of this Circle is no other than the Dialing Scale of 6 Hours, or a double Tangent divided into 90 Degrees.

Two Quadrants, or Half of this Circle beneath the Diameter, is divided into 90 equal Parts or Degrees.

The upper divided Quadrant, is called the Quadrant of Latitudes.

From the Extremity of the ſaid Quadrant, and Perpendicular to the Diameter, is graduated a Line of Proportional Sines, called the Line of *Sol.*

Diagonal-wiſe, from one Extremity of the Quadrant of Latitudes to the other, is graduated a Line of Sines; that End number'd with 90 Deg. that is next the Diameter, being of the ſame Radius with the Tangents.

Oppoſite and Parallel thereto from 45 Deg. of the Semicircle, to the other Extremity of the Diamter, is placed a Line of Sines equal to the former.

Diagonal-wiſe, from the Beginning of the Line of *Sol,* to the End of the Diameter, is graduated a Line of Chords to 60 Degrees.

From the Beginning of the Diameter, but below it, towards 45 deg. of the Semicircle, is graduated the Projection Tangent, *alias,* a Semi-Tangent to 90 deg. being of the ſame Radius with the Tangent.

The other Quadrant of this Circle being only a void Line, there paſſeth through it, from the Center, a Tangent of 45 deg. for Dialing, divided into 3 Hours, with its Quarters and Minutes.

Below the Diameter is a void Space left, to graduate any Table at Pleaſure.

Note, The Projection hath been already treated of in the Uſe of the foregoing Quadrant, it being the ſame, therefore the ſame Directions will ſerve for finding the Hour and Azimuth.

Of the fitted Particular Scale, and the Line of Entrance belonging thereto.

THIS Scale ſerves to find both the Hour and Azimuth in the Latitude of *London,* to which it is fitted, in the equal Limb; by a Lateral or Poſitive Entrance, it conſiſts of two Lines of Sines.

The greater 62 deg. of a Sine, as large as can ſtand upon the Quadrant, the Radius of the leſſer is made equal to 51d. 30m. of the greater, being fitted to the Latitude: The Scale of Entrance ſtanding within the Projection, and abutting on the Line of Sines, is no other but a Portion of a Line of Sines, whoſe Radius is made equal to 38d. 30m. of the greater Sine of the fitted Scale; and this Scale of Entrance is numbered by its Complement up to 62d. as much as the Sun's greateſt Meridian Altitude is in this Latitude.

To find the Time of the Sun's Riſing and Setting.

Take the Sun's Declination from the leſſer Sine on the Left Edge of the Foreſide of the Quadrant, and enter it at the Declination in the Scale of Entrance, laying the Thread to the other Foot, according to the nearaſt Diſtance, and it ſhews the Time of the Riſing or Setting in the equal Limb. So when the Sun hath 13 deg. of *South* Declination, he riſeth at 8 min. paſt 7 in the Morning, and ſets 52 min. paſt 4 in the Afternoon.

To find the true Time of the Day.

In Summer, or Northwardly Declination, take the Diſtance between the Altitude in the greater Sine, and the Daclination in the leſſer Sine.

In Winter, take the Declination in the leſſer Sine, and with your Compaſſes add it to the Altitude in the greater Sine.

Theſe Extents enter at the Declination in the Scale of Entrance, and lay the Thread to the other Foot, according to the neareſt Diſtance, and in the Limb, it will lie over the true Time of the Day.

In Summer, when the Declination in the fitted Scale above the Altitude, the Hour is found from 6 towards Midnight, when below it, towards Noon.

Examp. When the Sun hath 13 deg. of *North* Declination, his Altitude being 39d. 10m. it will be 1 Quarter paſt 9 in the Morning, or 3 Quarters paſt 2 in the Afternoon; and when he hath the ſame *South* Declination, his Altitude being 16d. 14m. the Time of the Day will be the ſame.

To find the Sun's Amplitude.

Take the Declination from the greater Sine, and enter it at the Beginning of the Scale of Entrance, laying the Thread to the other Foot, according to the neareſt Diſtance, and it ſhews it in the Limb.

When the Sun hath 13d. of Declination, his Amplitude will be 21d. 12m.

To find the Sun's Azimuth.

In Summer, take the Diſtance between the Altitude in the leſſer Sine, and the Declination in the greater.

In Winter, or *South* Declination, take tbe Declination from the greater Sine; and add it to the Altitude in the leſſer Sine with your Compaſſes.

Theſe Extents enter at the Altitude in the Scale of Entrance, and lay the Thread according to the neareſt Diſtance; and in the equal Limb, it ſhews the Azimuth from the *Eaſt* or *Weſt*.

In Summer, when the Altitude falls below the Declination, the Azimuth is found from the *Eaſt* or *Weſt*, Northward, when above it, Southward.

So when the Sun hath 13d. of *North* Declination, his Altitude being 43d. 50m. the Azimuth will be found to be 45 deg. from the *Eaſt* or *Weſt*, Southward: and when he hath the ſame Declination Southward, his Altitude being 14d. 50m. he ſhall have the ſame Azimuth.

Theſe Scales are fitted to give the Altitude at 6, and the Vertical Altitude by Inſpection.

Againſt the Declination } Sine } { Stands the { Vertical Altitude or Depreſſion.
in the greater or leſſer } { Altitude or Depreſſion at Six.

When the Hour or Azimuth falls near Noon, mind againſt what Arch of the Line of Sines the Point of Entrance falls; the Thread may be laid to the like Arch in the Limb, and the reſpective Extents entered parallelly between the Scale and the Thread, and the Anſwer found in the Line of Sines.

The Uſes of the Graduated Circle on the Back-ſide of the Quadrant.

To find what Time the Sun will be due Eaſt *or* Weſt.

LAY the Thread over the Latitude in the Semicircle, and over the Declination on the Diameter, and in the Quadrant of Latitudes it ſhews the Arch ſought.

Example. When the Sun hath 15 deg. of *North* Declination, in our Latitude of *London*, the Hour will be found 12d. 18m. from 6, in Time 49m. paſt 6 in the Morning, or before it in the Afternoon.

To find the Hour of Sun-Riſing.

Example. Lay the Thread to the Complement of the Latitude in the Semicircle, and to the Declination on the Diameter, and in the Quadrant of the Latitude, it ſhews the Time ſought in Degrees, to be converted into common Time, by allowing 15 deg. to 1 Hour, and 1 deg. to 4 min.

So in the Latitude of *London*, 51d. 30m. when the Sun hath 15 deg. of Declination, the Aſcenſional Difference, or Time of Riſing from 6, will be 19d. 46 min. to be converted into Time, is 1 Hour, 16 Min. ½.

To find the Amplitude of the Sun.

Extend the Thread over 38d. 30m. in the Line *Sol* (which ſtands perpendicularly on the Diameter) and through the Declination, in the upper Sine next the Quadrant of Latitude, and it will interſect the oppoſite Parallel Sine at 33d. 42m. the Amplitude ſought; in our Latitude 51d. 30m. when the Declination is 20 deg. 12 min.

The Sun's Amplitude and Vertical Altitude, to find the Latitude.

Let the Amplitude be 33d. 42m. and the Vertical Altitude be 26d. 15m. Lay the Thread over 33d. 42m. the Amplitude counted in the Quadrant Latitude, and thro' 45, on the Diameter, holding it at the Interſection, with the Circle on the oppoſite Side, then lay the Thread over 26d. 15m. the Vertical Altitude, and it will interſect the Diameter at 38d. 30m. the Complement of the Latitude ſought.

The Uſe of the Quadrant *in* Navigation.

To find how many Miles or Leagues in each Parallel of Latitude, anſwer to one Degree of Longitude.

THIS is wrought by laying the Thread to 51d. 30m. in the Limb, on the Backſide of the Quadrant, accounting from the Left Edge to the Right, then take the neareſt Diſtance to it from 60 in the Equal Parts, which meaſured from the Center, will be found to be 37 $\frac{3}{10}$ Miles.

So in the Latitude of 00d. 00m. which is on the Equinoctial, 60 Miles anſwer a Degree of Longitude; in this Parallel 51d. 30m. there will be but 37 $\frac{3}{10}$ Miles.

The Courſe and Diſtance given, to find the Difference of Latitude in Leagues or Miles.

Example. A Ship ſailed S. W. by W. that is on a Rumb 56d. 15m. from the Meridian 60 Miles, the Difference of Latitude in Miles will be found to be 33 $\frac{3}{10}$ Miles, the Operation being all one with the former; lay the Thread to the Rumb in the Limb, and from 60 take the neareſt Diſtance to it, which meaſured in the Scale of Equal Parts, will be found as before.

The Courſe and Diſtance given, to find the Departure from the Meridian.

In the former *Example*, to find the Departure from the Meridian, lay the Thread to the Rumb, counted from the Meridian, or Right Edge towards the Left, that is, 56 deg. 15 min. which is S. W. by Weſt; then from 60, in the Equal Parts, it being the Miles ſailed, take the neareſt Diſtance to the Thread, laid as before, that is, over the Rhumb, and meaſure it in the Line of Equal Parts, you will find it to be 49 $\frac{9}{10}$ Miles, and ſo if the Converſe of this were to be wrought, it is evident, that the Miles of Departure muſt be taken out of the Scale of Equal Parts, and entered parallelly between the Scale and the Thread lying over the Rumb.

Note, Many more Examples and Propoſitions might be illuſtrated; but theſe are ſufficient: Thoſe that would have a Quadrant for this Purpoſe, may prick the Rumbs on the Quadrant's Limb.

Of the Stars placed upon the Quadrant.

All the Stars placed upon this Projection, are ſuch as fall between the Tropicks; and the Hour may be found by them with the Projection, as in the Uſe of the ſmall Quadrants; *Namely*, the firſt Quadrant treated of in the Book, therefore in this Place it will be needleſs to ſay any thing about them.

The

THE
DESCRIPTION and USE
OF A
Small Pocket QUADRANT,
Four Inches RADIUS.

THIS Quadrant hath but one Face.

On the Right Edge from the Center is placed a Line of Sines, divided into Degrees and Half Degrees up to 60; afterwards into Whole Degrees to 180 Degrees.

On the Left Edge, iſſuing from the Center, is a Line of 10 Equal Parts, being preciſely 4 Inches long, each Part being divided into 10 Subdiviſions, and each Subdiviſion into Halfs,

Theſe two Lines make a Right Angle in the Center, and between them include a Projection of the Sphere for the Latitude of *London*.

Above the Projection are put on, in Four Quadrants of Circles, the Days of the Months; and in another, the Line of the Sun's Declination; and above them, the Names of Five Stars, with their Right Aſcenſions graved againſt them, and a General Almanack.

Beneath the Projection, are put on, in Quadrants of Circles, a particular Sine and Secant, ſo called, becauſe it is particular to the Latitude of *London*.

Below that the Quadrant and Shadows.

Below that a Tangent Line to 45 Degrees.

Laſt of all the Equal Limb.

On the Left Edge is placed a Dialling Scale of Hours, 4 Inches long; outwardmoſt on the Right Edge a Line of Latitudes fitted thereto.

Within the Line of Sines cloſe abutting thereto, is placed a ſmall Scale of Entrance, beginning againſt 52d. 35m. of the Sines, numbre d to 60.

The Line of Sines that iſſueth from the Center, ſhould for a particular Uſe have been continued longer, to wit, to a Secant of 28 deg. but becauſe this could not be admitted, the ſaid Secant is placed outward, at the End of the Scale of Entrance, toward the Limb; and as much of the Sines as was needful, placed, at its due Diſtance, at the other End of the Scale of Entrance.

Of the Uſe of the ſaid Quadrant.

The Almanack hath been ſpoke to from Page 5.

The Quadrant and Shadows from Page 16.

The Line of Latitudes and Hour-Scale, not yet ſpoke to.

The Uſe of the Projection.

This Projection is only fitted for finding the Hour in the Limb, and not the Azimuth; all the Circular Lines on it are Parallels of Altitude or Depreſſion, except the Ecliptic and the Horizon; the Ecliptic is known by the Characters of the Sines, and the Horizon lieth beneath, it being numbered with 10, 20, 30, 40.

The Parallels of Altitude, that are the Winter Parallels, are numbered from the Horizon upwards, towards the Center; the Parallels of Altitude or Depreſſion uſed in Summer, are numbered downward, from the Top of the Projection towards the Limb.

To find the Hour of the Day.

Having taken the Altitude of the Sun, and rectified the Bead to the Ecliptic, by laying it over the Day of the Month, or over the Sun's Declination: If the Sun hath *South* Declination, bring the Bead to that Parallel of Altitude on which the Sun's Height was obſerved, amongſt thoſe Parallels that are numbered upwards, towards the Center, and the Thread in the Limb ſheweth the Time of the Day.

Examp. So when the Sun hath 15 deg. of *South* Declination, as about the 28th of *January*, if his Altitude be 15 deg. the Time of the Day will be 39 min. paſt 2 in the Afternoon, or 21 min. paſt 9 in the Morning.

But in the Summer Half-Year, bring the Bead to lie on thoſe Parallels that are numbered downwards towards the Limb, and the Thread ſheweth therein the Time of the Day ſought.

Examp. If on the 2d of *Auguſt*, his Declination being 15 deg. his Altitude were 40 deg. the true Time of the Day would be 8 min. paſt 9 in the Morning, or 52 min. paſt 2 in the Afternoon.

If the Bead will not meet with the Altitude given amongſt thoſe Parallels that run downwards towards the Right Edge, then it muſt be brought to thoſe Parallels that lie below the Horizon, downwards towards the Left Edge, and the Thread in the Limb ſhews the Time of the Day, before 6 in the Morning, or after it in the Evening, in Summer.

Examp. When the Sun hath 15 deg. of *North* Declination, as on the 2d of *Auguſt*, if his Altitude be 5 deg. the Time of the Day will be 44 min. before 6 in the Morning, or after it in the Evening.

To find the Sun's Azimuth.

Examp. Becauſe this Projection is not fitted for finding the Azimuth, there are added two particular Scales to the Quadrant; Namely, the particular Sine in the Limb, and the Scale of Entrance abutting from the Sines, fitted for the Latitude of *London*.

Lay the Thread to the Day of the Month, and it ſhews the Declination of the Sun, in the Circle proper thereto. Then,

Count the Declination in the Limb, laying thereto the Thread; and in the particular Sine it ſhews the Sun's Altitude or Depreſſion, being *Eaſt* or *Weſt*.

To

To find the Azimuth.

For *North* Declination, take the Diſtance between the Sine of the Vertical Altitude, and the given Altitude; but for the *Sauth* Declination, add with your Compaſſes the Sine of the given Altitude, to the Sine of the Vertical Altitude; enter that Extent thus found, at the Altitude in the Scale of Entrance, laying the Thread to the other Foot, according to the neareſt Diſtance, and in the equal Limb it ſheweth the Azimuth ſought, from *Eaſt* or *Weſt*; or it may be found in the Sine, by laying the Thread to that Arch in the Limb that the Altitude in the Scale of Entrance ſtands againſt in the Sine, and entring the former Extent parallelly between the Thread and the Sine.

Examp. When the Sun hath 13 deg. of Declination, his Vertical Altitude or Depreſſion is 16 deg. 42 min. If his Declination were *North*, and his Altitude 8 deg. 41 min. his Azimuth would be 10 deg. to the Northward of the *Eaſt* or *Weſt*: But if it were *South*, and the Altitude 12 deg. 13 min. the Azimuth would be 40 deg. to the Southward of the *Eaſt* or *Weſt*.

To find the Time of Sun-Riſing, and his Amplitude.

Lay the Thread over the Day of the Month, and ſet the Bead to the Ecliptic, then carry the Thread and Bead to the Horizon; and the Thread in the Limb ſhews the Time of Riſing; and the Bead on the Horizon, the Quantity of the Amplitude.

Examp. On the 2d of *Auguſt*, the Sun's Declination being 15 deg. his Amplitude will be 24 deg. 35 min. and the Time of Riſing 41 min. paſt 4 in the Morning.

The DESCRIPTION and USE of the Horizontal Quadrant, with the Horizontal Projection upon it inverted.

This Denomination is attributed to it, becauſe it is derived from the Horizontal Projection inverted.

Of the Fore-ſide.

ON the Right Edge is a Line of Natural Sines.

On the Left Edge a Line of Verſed Sines.

Both theſe Lines iſſue from the Center, where they concur, and make a Right Angled Triangle; and between them, and the Circular Lines in the Limb, is the Projection included, which conſiſts of divers Portions and Arches of Circles.

Of the Parallels of the Sun's Declination.

Theſe are Portions of Circles, that croſs the Quadrant obliquely, from the Left Edge towards the Right.

Of the Line or Index of the Altitudes.

This is no other than a ſingle prickt Line, ſtanding next the Meridian Line, or Left Edge of the Quadrant, to which the Bead muſt be continually rectify'd, when either the Hour or Azimuth is found by the Projection.

Of the Hour Circles.

Theſe are known by the Numbers ſet to them, by croſſing the Parallels of Declination, and by iſſuing from the upper Part of the Quadrant towards the Limb.

The Deſcription of the Back-ſide.

Put on in Quarters of Quadrants of Circles.

1. The equal Limb divided into Degrees, and alſo into Hours, and Halfs, and the Quarters prickt, to ſerve for a Nocturnal.
2. A Line of Equal Parts.
3. A Line of Superficies or Squares.
4. A Line of Solids or Cubes.
5. A Tangent of 45 deg. double divided, to ſerve for a Dialling Tangent, and a Semi-Tangent for Projection.
6. A Line of Proportional Sines, *alias*, the Line of *Sol.*
7. A Tangent of 51 deg. 32 min. through the whole Limb.
8. A Line of Declination for the Sun, to 23 : 30.

9.
10.
11. Four Quadrants with the Day of the Month.
12.

13. The Sun's true Place, with the Characters of the twelve Signs.
14. The Line of Segments, with a Chord before they begin.
15. The Line of Metals and equiated Bodies.
16. The Line of Quadrature.
17. The Line of Inſcrib'd Bodies.
18. A Line of 12 Hours of Aſcenſion, with Stars Names, Declination, and Aſcenſional Differences.

Above all theſe, a Table to know the Epact, and what Day of the Week the firſt of *March* happens on by Inſpection, till the Year 1700; but that Year being paſt, I have taken the Pains to make a New One, commencing from 1700, and continued to the Year 1751.

All theſe between the Limb and the Center.

On the right Edge a Line of Equal Parts, from the Center decimally ſubdivided, being a Line of 10 Inches; alſo a Dialling Tangent, or Scale of 6 Hours, the whole Length of the Quadrant, not iſſuing from the Center.

On the left Edge a Tangent of 60 deg. 26 min. from the Center.

Alſo a Scale of Latitudes fitted to the former Scale of Hours, not iſſuing from the Center, and below it a ſmall Chord.

The Uſe of the Quadrant.

Sunday.	1702 11	☉	1713 14	1719 20	1724 15	1730 22	☉	1741 23	1747 29
Monday.	1703 23	1708 18	1714 25	☽	1725 26	1731 3	1736 28	1742 4	☽
Tueſday.	♂	1709 29	1715 6	1720 1	1726 7	♂	1737 9	1743 15	1748 11
Wedneſday.	1704 4	1710 11	☿	1721 12	1727 18	1732 14	1738 20	☿	1749 22
Thurſday.	1705 15	1711 22	1716 17	1722 23	♃	1733 25	1739 1	1744 26	1750 3
Friday.	1706 26	♀	1717 28	1723 4	1728 29	1734 6	♀	1745 7	1751 14
Saturday.	1707 7	1712 3	1718 9	♄	1729 11	1735 17	1740 12	1746 18	♄

A perpetual Almanack.

March.	1	8	15	22	29	November.
Auguſt.	2	9	16	23	30	Auguſt.
May.	3	10	17	24	31	January.
October.	4	11	18	25	0	October.
April.	5	12	19	26	0	July.
September.	6	13	20	27	0	December.
June.	7	14	21	28	0	February.

Of the Uſe the Projection.

Before the Projection can be uſ'd, the Sun's Declination is required, and by Conſequence the Day of the Month; for the ready finding thereof, there is repeated the ſame Table that ſtands on the Backſide of this Quadrant in each rul'd Space; the uppermoſt Figures ſignify the Years of our Lord, and the Column it is placed in ſheweth upon what Day of the Week the 1ſt of *March* happens in that Year; and the undermoſt Figure in the ſame rul'd Space, ſheweth what the Epact is for that Year, as is continued till the Year 1751.

Examp. Looking for the Year 1710, I find it ſtanding in *Wedneſday's* Column, whence I conclude, the 1ſt of *March* that Year falls on *Wedneſday*, and under it ſtands 11, the Epact that Year.

Of the Almanack.

Having found on what Day of the Week the 1ſt of *March* falls; repair to the Month you are in, and thoſe Figures that ſtand againſt it, ſhews you what Days of the ſaid Month, the Week-Days ſhall be the ſame that the 1ſt of *March* was.

Examp. Having found in the Year 1710, the firſt of *March* to fall on *Wedneſday*, look into the Column againſt *June* and *February*, you will find, that the 7th, 14th, 21ſt, and 28th Days of the Month will be all *Wedneſdays*; and thus much for the Almanack.

The Uſe of the Quadrant.

Without Rectifying the Bead, nothing can be performed by this Projection, except finding the Sun's Meridian Altitude, being ſhewn upon the Index, by the Interſection of the Parallel of Declination therewith.

How to find the Hour of the Day, and Azimuth of the Sun, by the Projection.

But before I ſhew you how to find the Hour and Azimuth, it will be convenient to ſhew how to find when the Sun is due *Eaſt* or *Weſt*, and alſo how to rectify the Bead.

1. To find when the Sun is due *Eaſt* or *Weſt*. Trace the Parallels of Declination to the Right Edge of the Projection, and the Hour it there interſects (in moſt Caſes to be duly eſtimated) ſhews the Time ſought: Thus, when the Sun hath 21 deg. of Declination *North*, we ſhall find, that he will be due *Eaſt* or *Weſt* about 3 Quarters paſt 4 in the Afternoon, or 1 Quarter paſt 7 in the Morning.

2. To rectify the Bead, and find the Hour and Azimuth. Suppoſe on the 24th of *April*, I would know the Time of the Day, I lay the Thread over it on the Backſide of the Quadrant, and in the Circle of Declination I find 16 deg. of *North* Declination (becauſe it is Summer.) Then holding up my Quadrant, I find the Sun's Height to be 45 deg. Then I lay the Thread on the Line, or Index of Altitude of the Foreſide of the Quadrant, and ſet the Bead, the obſerved Altitude, 45 deg. and bring the Thread to interſect the Parallel of Declination, *viz.* 16 deg. the Thread lies over 50 deg. 48 min. for the Sun's Azimuth from the *South.*

And the Bead among the Hours ſhews the Time of the Day to be 41 min. paſt 9 in the Morning, or 19 min. paſt 2 in the Afternoon.

An Example wherein the Operation will be upon the reverted Tail.

Let the Altitude be 3 deg. 30 min. and the Declination 16 deg. as before. To know how to rectify the Bead to the upper or neather Altitude, will be no Matter of Difficulty; for if the Bead being ſet to the neather Altitude, will not meet with the Parallel of Declination, then ſet it to the upper Altitude, and it will meet with the Winter Parallels of the like Declination, which, in this Caſe, ſupplies the Turn.

So in this Example, the Bead being ſet to the upper Altitude of 3 deg. 30 min. and carried to the Winter Parallel of Declination, the Thread in the Limb will fall upon 58 deg. 28 min. for the Sun's Azimuth from the *North*, and the Bead among the Hours ſheweth the true Time of the Day, to be either 5 in the Morning, or 7 at Night.

Another Example.

Admit the Sun hath 20 deg. of *North* Declination, (as about the 9th of *May*) and his obſerved Altitude were 56 deg. 20 min. and the Hour and Azimuth were required.

Having rectified the Bead thereto, and brought it to interſect the Parallel of 20 deg. among the Hours, it ſheweth the Time of the Day to be 11 in the Morning, or 3 in the Afternoon, and the Azimuth of the Sun to be 26 deg. from the *South.*

The Uſes of the Projection.

To find the Sun's Altitude on all Hours or Azimuth, will be but the Converſe of what is already ſaid, therefore one Example will ſerve.

When the Sun hath 45 deg. of Azimuth from the *South*, and his Declination 13 deg. Northwards.

Lay the Thread over 45 deg. in the Limb, and where the Thread interſects the Parallel of Declination thereto, remove the Bead, which carried to the Index without ſtretching, ſhews 43 deg. 50 min. for the Altitude ſought.

Likewiſe to the ſame Declination, if it were required to find the Sun's Altitude for the Hour of 10 or 2. Lay the Thread over the Interſection of the Hour propoſed, with the Parallel of Declination, and thereto ſet the Bead, which carried to the Index, ſhews the Altitude ſought, *viz.* 44 deg. 31 min.

The ſame Altitude alſo belongs to that Azimuth, the Thread in the former Poſition lying over in the Limb.

Of the Curved Line, and Scales belonging it.

Beyond the Middle of the Projection, ſtands a curved or bending Line, numbered from O or Cypher both Ways; one Way to 60 deg. but divided to 62 deg. the other Way to 20 deg. but divided to 23 deg. 30 min.

Lines belonging to it are two; the one a Line of Altitudes and Declination, ſtand outermoſt on the Left Edge of the Quadrant, numbered from O or Cyphet two Ways; one Way to 62 deg. the other Way to 23 deg. 30 min.

The other Line is 130 deg. of a Line of Verſed Sines, which ſtands next without the Projection amongſt thoſe Lines juſt over the Almanack, and being parallel to the Left Edge of the Quadrant.

Prob. I. *To find the Time of the Sun's Riſing and ſetting by the Curve.*

Having found the Sun's Declination on the Backſide of the Quadrant, lay a Ruler on O or Cypher in the Line of Altitude on the Left Edge, and over the Sun's Declination in the Curve accounted from O, and in the Verſed Sine for the Curve, it ſhews the Time of the Sun's Riſing and Setting, which being as much from 6 towards Noon in Winter, as towards Midnight in Summer, the Quantity of Declination ſuppoſed a-like both Ways, on each Side of the Equinoctial, the Ruler may be laid either Way from O in the Curve to the Declination.

Examp. On the 9th of *May*, lay the Thread over the ſaid Day, and you will find the Sun's Declination to be 20 deg. then the Ruler being laid over 20 deg. in the Curve, and from O in the Altitude on the Left Edge, ſhews, that the

Sun	riſeth	1 Hour	before	6 in Sum-	riſeth	as much	after	6 in Winter
	ſetteth	49 Min.	after	mer, and	ſetteth		before	

Prob.

Prob. II. *The Altitude and Declination of the Sun being given, to find the Hour of the Day.*

Count the Altitude from O in the Scale of Altitudes towards the Center, and thereon lay one End of your Ruler, then count the Declination from O in the Curve, if *North* upwards towards the Center, if *South* downwards towards the Limb; and there lay the other End of the Ruler, and in the Verſed Scale it ſhews the Time ſought.

Examp. The Altitude 24, 46. the Declination 20 deg. *North*, counting that upwards in the Scale of Altitudes, and this upwards in the Curve, laying the Ruler to thoſe two Points, will cut the Verſed Scale at 7 and 5, ſhewing the Hour to be either 7 in the Morning, or 5 in the Afternoon.

Prob. III. *To find when Twilight begins.*

Let the Sun's Declination be 13 deg. *North*, the Depreſſion ſuppoſed 18 deg. under the Horizon.

Inſtead of the Caſe propounded, ſuppoſe the Sun to have 13 deg. *South* Declination, and his Altitude 18 deg. above the Horizon, accordingly laying your Ruler over 18 in the Altitudes counted from O, and over 13 in the Curve, counted from O, downwards, the Ruler will cut the Verſed Scale in 28 min. paſt 2 in the Morning, or 32 min. paſt 9 at Night; which ſhews that to be the Begining or Ending of Twilight.

Prob. IV. *To find the Sun's Altitude on all Hours.*

Lay your Ruler over the Hour propoſed in the Verſed Scale, and over the Declination in the Curve counted upwards, if *North*; and downwards, if *South*.

And in the Scale of Altitudes the Altitude ſought.

Example, If the Sun have 13 deg. of *North* Declination, his Altitude for the Hour of 7 in the Morning, or 5 in the Afternoon, will be found to be 19 deg. 27 min.

In the following Propoſitions, the Altitude muſt be always counted from O in the Curve downwards, and the Declination in the Line of Altitudes, if Northward, downwards; if *South*, upwards.

Prob. V. *To find the Sun's Amplitude, or Coaſt of Riſing and Setting.*

If the Sun have 20 deg. of Declination, the Ruler being laid to O in the Curve, and to 20 in the Line of Altitude or Declination, either upwards or downwards, will cut 33 deg. 21 min. from 90 in the Verſed Scale, for the Quantity of the Sun's Coaſt of Riſing or Setting from the true *Eaſt* or *Weſt*, in Summer Northward, in Winter Southward.

Prob. VI. *The Sun's Altitude and Declination being propoſed, to find his Azimuth.*

Count the Altitude from O in the Curve downwards, and the Declination in Winter upon the Line of Declination from O upwards, in Summer downwards; and the Ruler laid over theſe two Points, ſhews the Azimuth ſought, in the Verſed Sine.

Example.

Examp. So when rhe Sun hath 18 deg. 37 min. of *North* Declination, as about the 19th of *July*, if his Altitude were 39 deg. the Sun's Azimuth would be found to be 69 deg. from the *South*.

Prob. VII. *To find the Sun's Altitude on all Azimuths.*

Lay the Ruler to the Azimuth in the Verſed Scale, and to the Declination in the Scale of the Left Edge, and on the Curve it will interſect the Altitude ſought.

Example. If the Sun had 16 deg. 13 min. of *South* Declination, as about the 27th of *October*, if his Azimuth were 39 deg. from the *South*, the Altitude agreeable thereto would be found to be 14 deg.

Sect. I. *Of the* Quadrant *and* Shadows.

The Uſe of this is the ſame as in the ſmall Quadrant, only if the Thread hang over any deg. in the Limb leſſer than 45, to take the Tangent thereof out of the Quadrant, count the Arch from the Right Edge of the Quadrant towards the Left, and lay the Thread over it. The Pricks are repeated in the Limb, to ſave the Trouble for thoſe eminent Parts.

* * *

THE

Uſe of the Dialling SCALES:

SHEWING

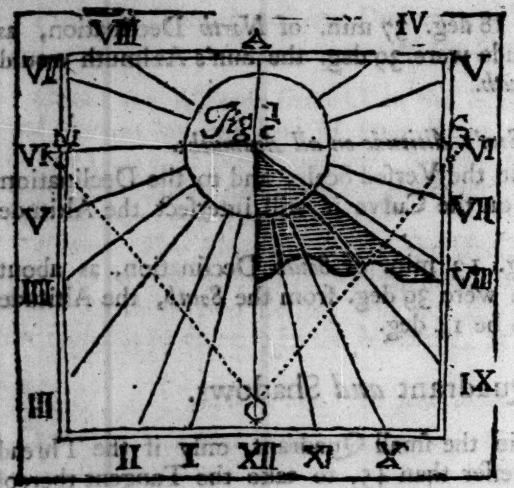
How to draw Hour Lines on all Horizontal Dials, Eaſt, Weſt, North *and* South *Dials*; *alſo declining Dials to any Declination: With an eaſy Way to draw declining Dials, without taking the Declination of the Plane.*

Sect. I. *How to draw an Horizontal Dial for the Latitude of 51 degrees 30 minutes*

1. DRAW the Line AB for the Meridian or Twelve a-Clock Line.

2. Draw NS Perpendicular to AB, for Six a-Clock Morning and Evening.

3. Let C, the Interſection of the aforeſaid Lines, be the Center of the Dial, then repair to your Line of Latitude, fixing one Foot of your Compaſſes at the Beginning, extend the other to 51d. 30m. and ſet off that Extent from C to N, and from C to S; then open your Compaſſes to the Length of the whole Line of Hours, and with that Extent, one Foot fixed in N, move the other till it meet with the Meridian-Line AO, as at O, and draw NO and SO.



4. This done, extend your Compaſſes from the beginning of your Hour-Scale, to the Hour 1, and ſet it off from O to 1, 11, and from N to 5, and from S to 7. Then extend your Compaſſes from the beginning of the ſaid Scale, to 2 Hours, and ſet it off from O to 2, and 10, alſo from N to 4, and from S to 8. Laſtly, extend your Compaſſes from the beginning of the ſaid Scale to 3 Hours, and ſet that off from O to 3, and from O to 9; So you have Hour-Points for 12 Hours. Now Lines drawn from C, the Center to each of thoſe Points, ſhall be the Hour required.

Note, 1. That the Hours of 4 and 5 in the Morning, and 7 and 8 in the Evening, muſt be drawn through the Center C, and if you deſire the halves and quarters, they are to be drawn, in all Reſpects, as the Hours.

2. With a Line of Chords make an Angle of 51d. 30m. for the Height of your Stile, and ſet it over the Meridian-Line C O, at Right Angle, and your Dial is finiſhed.

Sect. II. *How to make a direct* South-Dial, *in the Latitude of* 51 deg. 30 min.

It is almoſt needleſs to ſay any thing concerning the making of a Direct *South* Dial, for there is but little Difference between it and the Horizontal, only you muſt take Notice that this Plane reſpects the *South* Pole, which Pole is elevated thereon 38 Deg. 30 Min. (always) the Complement of the Latitude, therefore take 38 Deg. 30 Min. out of your Line of Latitudes, and finiſh your Dial, in all Reſpects, as you did the Horizonal; but obſerve, that whereas in that Dial the Hours of 1, 2, 3, *&c.* were ſet off on your Left-Hand of the Meridian, ſo the ſame Hours muſt, in this Dial, be ſet off on the Right-Hand of the Meridian.

Note, 2. That the Angle which the Stile makes with the Meridian, muſt (as I have ſaid before) be 38 Deg. 30 Min. And, Laſtly, That the Stile muſt ſtand at Right-Angles with the Plane.

Sect. III. *Concerning a direct* North-Dial.

A Direct *North*-Dial, is the ſame with the *South*, only the Stile muſt point upwards towards the *North*-Pole and the Hours about Midnight, as 9, 10, 11, 12, 1, 2 and 3, muſt be left out, and 4 and 5 in the Morning, and 7 and 8 in the Evening, muſt be drawn through the Center, as in the Horizontal Dial; ſo is your Dial finiſhed.

Sect. IV. *How to draw Hour-Lines upon a direct* East *or* West-Dial.

First, Let fall a b Perpendicular to the Horizon, then with the Chord of 60 deg. one Foot of your Compaſſes in a, deſcribe the Arch of a Circle b c; then take the Complement of your Latitude, out of your Line of Chords (which here at *London* is 38 deg. 30 min.) and ſet from b to c, to the Right Hand becauſe the Plane is *Weſt*; join a c, that is the Subſtile, which is the Hour-Line of 6.

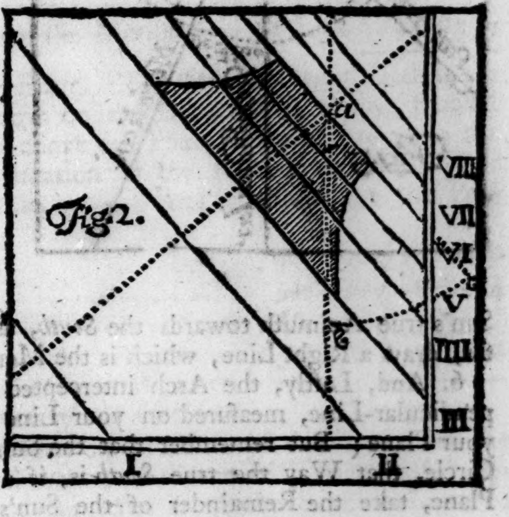


Fig. 2.

Though on an *Eaſt* or *Weſt*-Dial, the Stile has no Angle of Altitude; yet we muſt place a Stile of a convenient Length, about a third Part of the Plane, Parallel to the Subſtile, (or Perpendicular, which is all one) to give a Shade; let the Stile's Height be an Inch equal to 100 Parts; to the Subſtile apply Perpendicular at a, for the Equinoctial Line; then take the Number of Equal Parts, from the Line of Equal Parts, on the Right Edge of the Quadrant's Foreſide, as you ſee in the Table adjoined, belonging to each Hour, and place them upon the Equinoctial-Line, from the Subſtile, and draw Lines Parallel to it and through the Points, they ſhall be the Hour-Lines required.

1	373
2	173
3	100
4	58
5	27
6	00
Subſtile.	
7	27
8	58

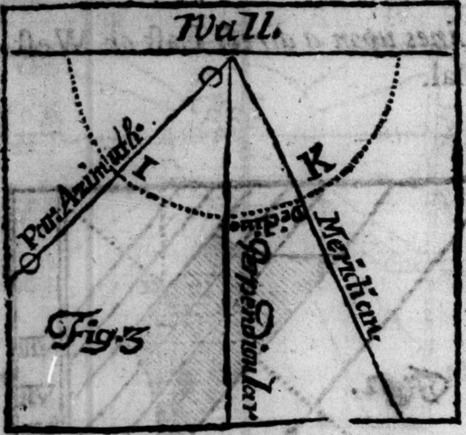
Note, That if you turn the *Weſt*-Dial drawn on Paper from you, and look on the Backſide, you ſhall ſee the perfect Form of an *Eaſt*-Dial, only inſtead of the Hours 1, 2, 3, 4, 5, 6, 7 and 8, you muſt write, 11, 10, 9, 8, 7, 6, 5 and 4.

Sect. V. *How to find the Declination of any Plane, from either the* South *or* North *Points of the* Horizon.

THERE are many Ways of the Declination of Planes; but the beſt and eaſieſt Way for Practice, is as followeth:

1. Draw a Line Parallel to the Horizon, upon the Wall you would take the Declination of.

2. Fix (or apply) a Plain Square Board having one Edge, to this Line, and Parallel to the Horizon, and having a Perpendicular Line drawn from the Edge, you apply to your Horizontal Line; then, when the Sun ſhines thereon, hold up a Line and Plummet, ſo as the Shadow of the Plum-Line may fall upon the Board, croſſing the Perpendicular Line, and make two Mark



Marks in the Shadow, a good Way diſtant from one another, and then inſtantly take the Sun's Altitude by your Quadrant.

3. Lay a Ruler to thoſe two Marks you made in the Shadow, and draw a Line, which I call the Pariatical Azimuth.

4. With the Altitude of the Sun before found, ſee what the Sun's Azimuth is by *Collin*'s Quadrant.

5. Take the Interſection of the Shadow Line, with the Perpendicular for a Center, and thereon with 60 deg. of Chords, deſcribe the Semicircle IK, then from I the Pariatical Azimuth, ſet off the Sun's true Azimuth towards the *South*, as to K; and through K and the Center, draw a Right Line, which is the Meridian-Line.

6. And, Laſtly, the Arch intercepted between the Meridian and the Perpendicular-Line, meaſured on your Line of Chords, gives the Declination of your Plane: But remember that the Sun's true Azimuth muſt be ſet on the Circle, that Way the true *South* is, if a *South* Plane; but if it be a *North* Plane, take the Remainder of the Sun's Azimuth to 180 deg. and ſet towards the true *North*. Thus you have the Quantity of the Plane's Declination.

Now to know whether your Plane decline *Eaſt* or *Weſt*.

If the Meridian Line falls on the Right Hand of the Perpendicular, your Plane declines *Weſt*; if on the Left Hand, your Plane declines *Eaſt*.

Sect. VI. *How to draw Hour-Lines upon* South *or* North *Planes, Declining either* Eaſt *or* Weſt, *in the Latitude of* 51. 30.

Before the Hour-Lines can be drawn on any of theſe Sorts of Planes Two Things muſt be given, and Three Things found.

The Things given are,

1. The Latitude of the Place, 51 deg. 30 min.
2. The Plane's Declination, 25. 00.

The Things that are to be found are,

1. The Subſtile's Diſtance from the Meridian.
2. The Height of the Stile.
3. The Inclination of Meridians.

How to find the Three Requiſites that muſt be known, for all upright Declining Planes in this Latitude, you may find treated of in the Diagonal Scale.

But to make this Treatiſe the more compleat, I ſhall here ſhew you how to calculate them, and what every one of theſe Arches are.

1. Of the Subſtile's Diſtance from the Meridian. By the Subſtilar Line is meant a Line, over which the Stile ſtandeth in its neareſt Diſtance from

the Dial, by ſome called the Line of Deflexion, and is an Arch of the Plane between the Meridian of the Place, and the Meridian of the Plane. ——— The Diſtance where 'tis from the Line of 12, is to be found by this Proportion.

As the Radius	90 : 00	10000000
Is to the Sine of the Plane's Declination	25 : 00	9625948
So is the Co-Tangent of the Latitude	51 : 30	9900605
To the Tangent of its Diſtance from the Meridian	18 : 34	19526553

2. Of the Stile's Height above the Plane. The Stile of every Dial is the Wire, or that which gives the Shadow on the Dial, and is always Parallel to the Axis of the World; its Height above the Plane varies according to the Latitude of the Place, and the Declination of the Plane; and the farther a Dial declines, the lower is the Stile. ——— And it is found by this Proportion.

As the Radius	90 : 00	1000000
Is to the Co-ſine of the Latitude	51 : 30	979415
So is the Co-ſine of the Plane's Declination	25 : 00	995127
To the Sine of the Stile's Height	34 : 21	975142

3. *The Inclination of the Meridian*

Is an Arch of the Equinoctial, between the Meridian of the Plane, and the Meridian of the Place; or if it is an Angle, or Space of Time elapſed between the Paſſage of the Shadow of the Stile, from the Subſtiler-Line, to the Meridian-Line, by ſome termed the Plane's Difference of Longitude; and not improperly; for it ſhews in what Longitude from the Meridian where the Plane is, the ſaid Dial would become an Horizontal-Dial, and the Stile's Height ſhews the Latitude; this Arch is uſed in calculating Hour-Diſtances by the Tables, and in pricking down Dials by the Line of Latitudes, and Hours from the Subſtile.

The Proportion.

As the Radius	90 : 00	1000000
Is to the Sine of the Latitude	51 : 30	989354
So is the Co-tangent of the Plane's Declination	25 : 00	1033132
To the Co-tangent of the Planes Longitude	30 : 47	1022486

Having found the Requiſites belonging to this Dial, declining 25 deg. proceed to draw the Hours in this manner.

1. Draw an Horizontal Line upon your Plane.

2. Draw C 12 for the Meridian or 12 a-Clock Hour-Line, Perpendicular to the Horizontal-Line of your Plane, and with a Line of Chords make the Angle F C 12, equal to the Subſtile's Diſtance from the Meridian, and draw the Liue C F for the Subſtile on the Right Hand of the Meridian, becauſe the Plane declines Weſtward.

3. Draw the Line A B Perpendicular to the Subſtile, and paſſing through the Center at C, then off of your Line of Latitudes on your Quadrant, take 34 deg. 21 min. (the Height of your Stile) and ſet from C to A, and C to B; then take in your Compaſſes the whole Scale of Six Hours, and one Foot in A, turn the other about till it touches the Subſtile, as at F, and draw the Lines F A and F B.

4. The Inclination of the Meridians in this Example, is ſound to be 30 deg. 47 min. which is 2 Hours 3 Minutes; therefore take off 2 Hours 3 Minutes from the Scale of Hours, and ſet it from F to 12, and from B to 6. Then extend your Compaſſes from the Beginning of your Scale to 00 Hours 3 min. and ſet that from F to 2, and from B to 8. Then open your Compaſſes to 1 Hour 3 min. and ſet it from F to 1, and from B to 7. Then open your Compaſſes to 3 Hours 3 min. and ſet from F to 11, and from B to 5. Then open your Compaſſes to 4 Hours 3 min. and ſet from F to 10, and from B to 4. Then open your Compaſſes to 5 Hours 3 min. and ſet from P to 9, and from B to 3. Now if you draw Lines from C through theſe Points, they ſhall be the Hours proper for this Plane: The Hour of 8 in the Afternoon being above the Horizontal-Line, if you draw it through the Center, it will be the Hour of 8 in the Morning.

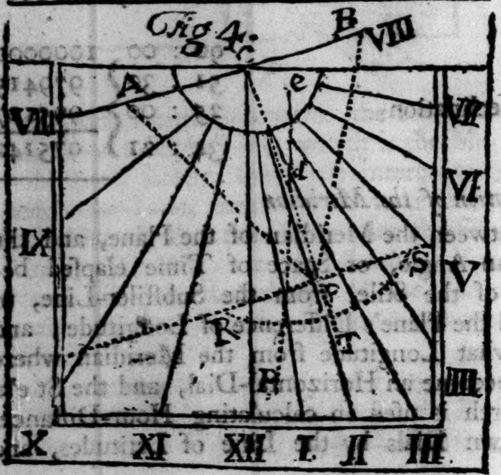


Fig. 4.

H.	M.	From F to A.		From B to F.
0	3	F 2		B 8
1	3	F 1		B 7
2	3	F 12	And	B 6
3	3	F 11		B 5
4	3	F 10		B 4
5	3	F 9		B 3

5. And laſtly, the Stile of this Dial muſt be elevated 30 deg. 21 min. and ſet Perpendicular upon the Subſtile.

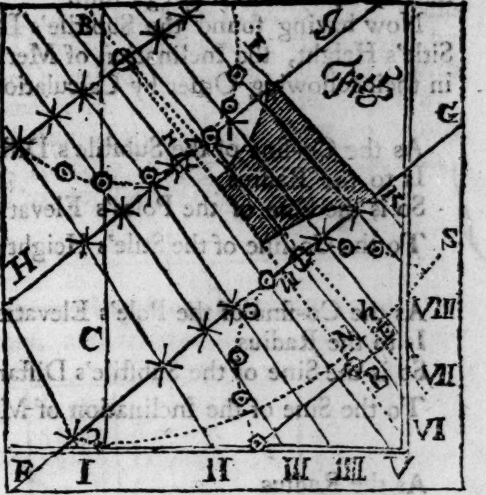
Note, 1. In the making of this Dial you have made three other of the ſame Declination, *viz.* A *South-Eaſt* Decliner, if you change the Side, and Number ſet to the Hours, the Complement to 12. 8. make 4. and 9. 3, *&c.*

2. If the Face of your Dial be towards the *North*, you muſt turn the Dials the Bottoms upwards, and reckon the Hours the contrary Way; ſo that a *South-Weſt* Decliner will be a *North* Decliner, and a *South-Eaſt* Decliner will be a *North-Eaſt* Decliner, leaving the Hour-Lines (which will be needleſs) before the Sun-ſetting, and after the Sun-riſing.

Sect. VII. *How to draw the Hour-Lines upon a Far Declining Dial Geometrically.*

Let the Declination given be 80 deg. *Weſtward.*

1. Draw the Line BC, Perpendicular to the Horizon of the Plane.



2. Upon C, with 60 deg. of Chords deſcribe the Arch QS. Then proceed to find the three Requiſites, having found them, take 38 deg 04 min. the Subſtile's Diſtance from the Meridian, and ſet from Q to N. Take alſo the Stile's Height 6 deg. 12 min. and ſet from N to H.

3. Draw BD for the Subſtile, and BE for the Stile: Then at ſome convenient Diſtance, draw KL, Parallel to CE the Stile. Alſo aſſume any two Points in the Subſtile, and through them draw the Perpendiculars FG and HI.

4. Take the neareſt Diſtance from T to KL, and from U to KL, and ſet it from T to R, and from U to D.

5. Upon D and R, with 60 deg. of Chords deſcribe two Arches of a Circle, and ſet off the Inclination of Meridians from T to P, and from U to O. With 15 deg. of Chords divide the Segment into equal Parts, beginning at O and P.

6. Lay a Ruler from D, and on each Diviſion in the Arch UO, and mark the Interſection of the Rule with the Line FG. Then lay the Rule to R, and work after the ſame manner in the other Arch, and HI.

7. Thro' the Marks made in FG and HI, draw the Hour-Lines.

Note, 1. When the Plane declines *Eaſt*, the Perpendicular CB, muſt be put on the Right Hand.

2. That the Inclination of Meridians muſt be ſet on the ſame Side of the Subſtile, with the Perpendicular. Thus you have finiſhed your Dial, and in the making of it you have made Four, if you conſider what was ſaid in the laſt Section.

Sect. VIII. *How to make an Upright* South-Dial, *without knowing the Declination of the Plane, the Elevation of the Pole being given.*

Firſt, Place a Pin in the Plane at leaſt ſix Inches long, as de, almoſt upright, but a little inclining; then with a Square find the Point directly under it, which is the Subſtile Point. In the Morning, if the Sun ſhines on the Plane, obſerve the End of the Shadow of the Pin (which is a Point of the Stile) as at R, and through it draw a Circle, whoſe Center is the Subſtile Point. At ſome other Time of the Day mark where the End of the Stile's Shadow does come to ſome other Point of the ſame Circle, as at S, connect thoſe two Points, RS, then the Line RS will be a Tangent to the Subſtile. From the Subſtile Point d, let fall a Perpendicular to that Tangent-Line as Fd, which is the Subſtile. From d with a Line and Plummet, let fall a Perpendicular to the Horizon, as dP. Then the Angle PdF is the Subſtile's Diſtance, equal to 18 deg. 34 min.

Now having found the Subſtile's Diſtance, we will proceed, and find the Sitle's Height, the Inclination of Meridians, and the Declination of the Plane, in their following Order by Calculation.

As the Co-ſine of the Subſtile's Diſtance	18 : 34	9.976787
Is to the Radius	90 : 00	10.000000
So is the Sine of the Poles's Elevation	51 : 30	9.893544
To the Co-ſine of the Stile's Height	34 : 21	9.916757

As the Co-ſine of the Pole's Elevation	51 : 30	9.794149
Is to the Radius	90 : 00	10.000000
So is the Sine of the Subſtile's Diſtance	18 : 34	9.502984
To the Sine of the Inclination of Meridians	30 : 47	9.708835

As the Radius	90 : 00	10.000000
Is to the Tangent of the Pole's Elevation	51 : 30	10.099395
So is the Tangent of the Subſtile's Diſtance	18 : 34	9.526197
To the Sine of the Plane's Declination	25 : 00	9.625592

Laſtly, Having found all the Requiſites, the Dial is to be drawn by the Directions of the Vth Section.

Sect. IX. *How to find the Requiſites of upright Decliners, by the particular Lines on the Quadrant, without proportional Work.*

1. To find the Subſtile's Diſtance from the Meridian, Account the Plane's Declination on the Line of Sines, on the Right Edge of the Foreſide of the Quadrant, and juſt againſt it in the Part. Scale annexed to it ſtands the Subſtiles's Diſtance from the Meridian. ——— If an upright Plane decline 30 deg. the Subſtile's Diſtance from the Meridian will be 21 deg. 41 min.

2. For the Stile's Height, Count the Complement of the Plane's Declination on the Right Edge of the Quadrant, and apply the Extent with Compaſſes from the Center, on the Line of Sines iſſuing from the Center on the Right Edge of the Foreſide of the Quadrant, and it will reach to 32 min. 37 min.

3. For the Inclination of the Meridians, Count the Height in the Part. Scale, and againſt it on the outermoſt Line of Sines, ſtands 53 deg. 35 min. whoſe Complement 36.25, is the Plane's Inclination of the Meridian.

	d. m.
If the Plane's Declinatin be	25 : 00
The Stile's Height will be	34 : 21
The Subſtile's Subſtance will be	18 : 34
The Plane's Longitude will be	30 : 47

Thus I have ſhewed how to draw any upright, Direct, and Declining Dial by theſe Scales; it may be expected I ſhould do the like for Reclining, or Inclining Dials; but it is too large a Tract for this Treatiſe: But thoſe that deſire to know more of the Art of Dialling, may gratify themſelves by purchaſing a Treatiſe (I lately publiſhed) called *Univerſal Dialling*, with Tables calculated for the Latitude of *London*, in which there are eaſy Directions for the drawing of all manner of Sun-Dials; likewiſe how to Adorn them with all manner of uſeful Furniture, relating to the Courſe of the Sun; you may have them at Meſſ. *Mount* and *Page* an *Tower-Hill*.

A TABLE of the Latitude of the moſt eminent Places in *England*, *Wales*, *Scotland*, and *Ireland*.

	d.	m.		d.	m.		d.	m.
London	51	30	*Rocheſter*	51	29	*Exeter*	50	43
York	54	00	*Peterborough*	52	33	*Durham*	54	50
Cambridge	52	17	*Chicheſter*	50	48	*Lincoln*	53	15
Norwich	52	44	*Hertford*	52	14	*SCOTLAND*.		
Canterbury	51	27	*Newark*	53	02	*Edenburg*	55	56
Briſtol	51	30	*Stafford*	52	55	*Glaſcow*	55	52
Colcheſter	52	04	*Shrewsbury*	52	48	St. *Johnſtown*	57	44
Cheſter	53	20	*Lancaſter*	54	08	St. *Andrews*	57	45
Caermarthen	52	02	*Wincheſter*	51	10	*Sterling*	57	18
Coventry	52	30	*Pembrook*	51	46	*Berwick*	55	49
Darby	53	06	*Worceſter*	52	20	*Aberdeen*	58	40
Oxford	51	45	*Nottingham*	53	03	*IRELAND*		
Glouceſter	52	00	*Hull*	53	50	*Dublin*	53	11
Hereford	51	51	*Ipſwich*	52	08	*Kingſale*	51	40
Monmouth	51	51	*Bedford*	52	08	*Wexford*	52	18
Yarmouth	52	45	*Huntingdon*	52	59	*Waterford*	52	22
Warwick	52	25	St. *David's*	52	00	*Limerick*	52	30
Flint	53	17	*Gilford*	51	12	*King's Town*	53	08
Salisbury	57	00	*Newcaſtle*	54	58	*Queen's Town*	52	52

Sect. X. *By the* Epact, *to find the Moon's Age, and the Time of her coming to the* South.

Add to the Day of the Month the Epact which you may find by the foregoing Table) and ſo many Days more as are Months from *March*, to the Month you are in, including both Months, the Sum (if leſs than 30) is the Moon's Age; if more, ſubtract 30, and the Remainder is the Moon's Age.

Example. The *Epact* for the Year 1710 is 11, and let it be required to know the Moon's Age the 28th of *June*, being the fourth Month from *March*, both incluſive.

11
28
4

The Sum of the three 43

Whence rejecting 30, the Remainder is 13 for the Moon's Age ſought.

The former Rule ſerves when the Month hath 31 Days, but if the Month hath but 30 Days, or leſs, take but 29. To find the Moon's *Ssuthing*, multiply her Age by 4, and divide by 5, the Quotient ſhews it, every Unit that remains is 12 min. of Time, and becauſe when the Moon is at the Full, or 15 Days old, her Southing is at the Hour of 12 at Midnight, for Eaſe in Multiplication and Diviſion, when her Age exceeds 15 Days, reject 15 Days from it.

Examp[illegible] So when the Moon is 13 Days old, ſhe comes to the *South* 24 min. paſt 10 at Night, which being known, her Riſing or Setting may be gueſſed at to be 6 Hours more or leſs, before her *Southing*, and her Setting as much after, but in Regard of her varying in Declination, no general Rule for Memory is certain. Here it may be noted, that the firſt 15 Days of the Moon's Age, ſhe comes to the Meridian after the Sun, being to the *Eaſtward* of him, and the latter 15 Days, ſhe comes to the Meridian before the Sun, being *Weſtward* of him.

Sect. XI. *To find the Time of High-Water by the* Moon's *Age, or* Southing, *by the following Table.*

Moon's Age.		Moon's Southing.		Tide at *Lond.* Br.	
Days.		h.	m.	h.	m.
0	15	12	00	3	00
1	16	12	48	3	48
2	17	1	36	4	36
3	18	2	24	5	24
4	19	3	12	6	12
5	20	4	00	7	00
6	21	4	48	7	48
7	22	5	36	8	36
8	23	6	24	9	24
9	24	7	12	10	12
10	25	8	00	11	00
11	26	8	48	11	48
12	27	9	36	12	36
13	28	10	24	1	24
14	29	11	12	2	12

I think this Table needs not much Explanation, for it is plain. when the Moon is 8 Days old, ſhe is *South* 24 min. paſt 6 in the Afternoon, and it is High-Water at *London-Bridge* 3 Hours after, which is 24 min. paſt 9 at Night. And when ſhe is 23 Days old, ſhe is *South* 24 min. paſt 6 in the Morning, and it is High-Water at 25 min. paſt 9 in the Morning; and ſo of the reſt.

This Rule may in ſome Meaſure ſatisfy and ſerve for vulgar uſe, for ſuch as have occaſion to go by Water, and but that there was ſpare-room to grave on the *Epact* in the foregoing Table, in Page 29, elſe nothing at all ſhould have been ſaid thereof in this Treatiſe.

Sect. XII. *Of the Line of Inſcribed Bodies.*

This Line hath theſe Letters ſet to it.

D.	Signifying the Sides of a	Dodecahedron.
S.		
I		Icoſahedron.
C		Cube.
O		Octohedron.
T		Tetrahedron.

And the Letter S ſignifieth the Semidiameter of a Sphere, the Uſe whereof is to find the Sides of the Five Regular Bodies that may be inſcribed in a Sphere.

Example. Suppoſe you have a Deſire to cut the Five Regular Bodies in Paſtboard to be all of one Height, when folded up: Or, a Joyner Deſire to cut them of thin Wainſcot, and glue them together; but doth not know the Length of the Sides of the ſaid Regular Bodies, that may be inſcribed in a Sphere of any given Diameter. .... But ſuppoſe 6 Inches were given.

Lay the Thread over S, and take in your Compaſſes 3 Inches, half the Diameter, out of your Line of Equal Parts, or Inches, and with that Extent move one Foot upwards or downwards in the Line of Inches, until the other turned about will but juſt touch the Thread, the reſting Point thus found (which in this Example is in 4 Inches, 90 Parts) I call the Point of Entrance, from the ſaid Point take the neareſt Diſtance to the Thread laid over the Letters.

		Inches.	Decimal Parts 100.
D	And meaſure thoſe	2	13
I	Extents on the Line	3	15
C	of Inches, and you	3	45
O	will find them to	4	23
T	reach to	4	86

Which are the Dimenſions of the reſpective Sides of thoſe Bodies to which the Letters belong.

Sect. XIII. *To find the Requiſites for direct* Eaſt *and* Weſt *Recliners or Incliners, for this Latitude.*

1. *The Subſtile's Diſtance.*

Account the Plane's Reclination or Inclination in the Limb on the Backſide from the Left Edge, and there lay the Thread, and in that Circle marked with 51.32 Part. Sine, the Thread cutteth the Arch ſought.

So the Thread laid over 60, the Plane's Reclination, will cut the Part. Sine, in 32 deg. 12 min.

2. *For the Stile's Height.*

Account the Plane's Reclination or Inclination in the Part. Sine, on the Foreſide of the Quadrant from the Right Edge, and there lay the Thread, and it cuts the Limb in the Arch ſought, which in this Example will be found to be 42 deg. 41 min. numbred from the Right Edge.

3. *For the Inclination of the Meridians.*

The Canon for Calculation is,

As the Radius	90	00	10.00000
Is to the Sine of the Latitude the Complement Arith.	51	30	10.10645
So is the Sine of the Subſtile's Diſtance	32	12	9.972662
To the Sine of the Plane's Longitude	42	53	1.983307

But if the Subſtile's Diſtance from the Meridian be leſs than the Latitude of the Place, (as in this Example it is) it may be found in the Part. Sine, on the Foreſide, by laying a Thread in the Limb, over the Subſtile's Diſtance numbred from the Right Edge.

For the Angle of 12 *and* 6.

Account the Complement of the Plane's Reclination or Inclination in the Sines of the Right Edge of the Foreſide of the Quadrant, and againſt it in the Part. Scale annexed to it, ſtands the Complement of the Angle ſought. So that if an *Eaſt* or *Weſt* Plane recline 60 deg. againſt 30 deg. the Complement of the Reclination in the Sines ſtands 21 deg. 40 min. whoſe Complement 86 and 20, is the Arch ſought.

There are ſeveral other Lines; as the Lines of Superficies and Solids, the Lines of Quadrants, Segments, Metals, and equated Bodies, which I leave to the Diſquiſition of the Reader, when he ſhall have Time to put them in Practice, which, I think, will be ſeldom or never, and wherein the Aſſiſtance of the Pen will be more commendable.

Theſe Lines were added to this Quadrant to fill up ſpare Room, and to ſhew, that what can be done by the Sector, may be done by the Quadrant.

Sect. XII. *Of the placing of the Stars on this Projection, and on other Places of the Foreſide of the Quadrant.*

Such Stars only are placed on this Projection, as fall between the Tropics, being put on according to their true Declination, and in that Reſpect might have ſtood any where in the Parallel of Declination; but in Regard we ſhall find the Time of the Night with Compaſſes, they are alſo put on in a certain Angle from the Right Edge of the Quadrant, to find the Quantity of that Angle; for Stars of Northerly Declination get the Difference of the Sines of the Stars Altitude from the Meridian, and of its Meridian Altitude, and find to the Sine of what Arch the ſaid Difference is equal; againſt that Arch in the Limb, let the Star be graduated in its Declination; but for Stars of *South* Declination, get the Sum of the Sines of their Depreſſion at 8ix, and of their Meridian Altitude, and find what Arch in the Sines correſponds thereto, as before.

We have put on no Stars of Southwardly Declination, that will fall beyond the Winter-Tropic; but ſome of Northerly Declination, falling without the Summer-Tropic, are put on, that are placed without the Projection towards the Limb.

All theſe Stars muſt be graduated againſt the Line of Sines at their reſpective Altitudes, or Depreſſion, at the Stars Hour of Six from the Meridian, and muſt have the ſame Letters ſet to them in both Places; as alſo upon the Quadrant of 12 Hours of Aſcenſion on the Backſide, where they are put on according to true Aſcenſion, with their Declination and Right Aſcenſional Differences graved againſt them, with the former Letters; and ſuch of them as have more than 12 Hours of Right Aſcenſion, have the Character *Plus* † affixed, denoting, that if there be 12 Hours of Aſcenſion added to that Aſcenſion that ſhould ſtand, the Sum is their whole true Right Aſcenſion.

Prob. I. *To find the Quantity of a Star's Hour from the Meridian by the Projection.*

Set the Bead upon the Index of Altitude to the Star's obſerved Altitude, and bring it to the Parallel of Declination the Star is graved in, ſo will it ſhewd among the Hour-Lines, that Star's Hour from the Meridian, and the Threa in the Lmb will ſhew the Star's Azimuth.

Examp. Admit the Altitude of *Arcturus* be 52 deg. the Hour of that Star from Midnight, if the Altitude increaſes, will be 7 min. paſt 10, and the Azimuth of that Star will be 47 deg. 43 min. to the Eaſtward of the *South.*

The Hour and Azimuth of any Star within the Tropics, may be found by the fitted Scale on the Right Edge of the Quadrant, or by the Curve, after the ſame manner as for the Sun, uſing the Star's Declination as was done for the Sun, or in the equal Limb, as was ſhewed for the Sun, which may well ſerve for moſt of the Stars in the Hemiſphere.

Otherwiſe with Compaſſes, according to the late ſuggeſted placing of them.

Prob. II. *To find the Hour of any Star from the Meridian that hath* North-*Declination.*

Take the Diſtance between the Star-Point in the Line of Sines, and its obſerved Altitude, and laying the Thread over the Star where it is graved on or below the Projection, enter the former Extent parallelly between the Thread and the Scale, and it ſhews the Star's-Hour from 6 in the Sines towards Noon, if the Altitude fell beyond the Star-Point, otherwiſe towards Midnight.

Example. For the *Goat*-Star, let its Altitude be 40, and paſt the Meridian the Hour of that Star will be 44 min. from 6, for the Compaſſes upon the Sine of 11. 4. the Hour is towards the Noon-Meridian, becauſe the Altitude is greater than 34. the Point where the Star is graved, the Thread lying over the Star interſects the Limb at 25. 47. If the Diſtance between the Star and its Altitude be entred at the Sine of the Arch, and the Thread laid to the other Foot, the Hour will be found in the equal Limb, the ſame as before.

Prob. III. *For Stars of Southwardly Declination.*

Becauſe the Star-Point cannot fall the other Way beyond the Center of the Quadrant, therefore the Diſtance between the Star-Point and the Center muſt be increaſed by adding the Sine of the Star's Altitude thereto, which will fall more outwards towards the Limb, and then the whole Extent is to be entred as before.

Example. The *Virgins-Spike* hath 9. 19. of *South*-Declination, the Depreſſion of that Star at 6 will be found by the Help of the particular Sine to be 7. 17. and at that Arch in the Sines the Star is graved; if the Altitude of that Star be 20, the Sine thereof added to the Star will be equal to the Sine of 29. 6. this whole Extent entred at the Sine of 37. 52. the Arch of the Limb againſt which the Star is graved, and the Thread laid to the other Foot, the Hour of that Star, if the Altitude increaſes, will be 19 min. paſt 9.

Prob. IV. *To find the true Time of the Night.*

This muſt be done by turning the Star-Hours in the Sun's-Hour or common Time, either by the Pen, as hath been ſhewed before, or it may be alſo conveniently performed by the Back of this Quadrant, for the Thread lying over the Day of the Month, ſheweth the Complement of the Sun's Aſcenſion in the Limb.

Or with Compaſſes on the ſaid Quadrant of Aſcenſion.

The Thread lying over the Day of the Month, take the Diſtance between it and the Star on the ſaid Quadrant, and the ſaid Extent being applied the ſame Way as it was taken, the other Foot ſhall reach from the Star's Hour to the true Hour of the Night; and if one of the Feet of the Compaſſes fall off the Quadrant, a double Remedy, is elſewhere preſcribed.

Example. If on the 12th of *January* the Hour of the *Goat*-Star was 16 min. paſt 5 from the Meridian, the true Time ſought would be 49 min. paſt 1 in the Morning.

Example. If upon the 3d of *January*, the Hour of the *Virgin's-Spike* was obſerved to be 19 min. paſt 9, the true Time ſought would be 45 min. paſt 2 in the Morning.

Prob. V. *To find the Time of the Star's Riſing and Setting.*

The Aſcenſional Difference is graved againſt the Star, the *Virgin's-Spike* hath 48 min. of Aſcenſional Difference, that is to ſay, that Star's Hour of Riſing is at 48 min. paſt 6, and the Setting at 12 min. paſt 5, and the true Time of the Star's Riſing upon the 3d of *January*, will be at 23 min. paſt 10 at Night, and will ſet at 47 min. paſt 8 in the Morning, found by the former Direction.

Of the reſt of the Lines on the Back-ſide of the Quadrant.

They are either ſuch as relate to the Motion of the Sun or Stars, or to Dialling, or ſuch as are derived from *Gunter*'s Sector.

The Tangent of 51. 30. put on through the whole Limb, is peculiarly fitted for the Latitude of *London*, and will ſerve to find the Time when the Sun will be *Eaſt* or *Weſt*, as alſo for any Time of the Stars that hath leſs Declination than the Place hath Latitude.

Lay the Thread to the Declination counted in the ſaid Tangent, and in the Limb it ſhews the Hour from Six, if reckoned from the Right Edge.

Example. When the Sun hath 15 deg. of *North*-Declination, the Time of his being *Eaſt* or *Weſt* will be 12 deg. 17 min. in Time about 49 min. before or after 6.

The Sun's Place is given in the Ecliptic-Line, by laying the Thread over the Month in the Quadrant of Aſcenſion. See in the Uſe of the firſt mentioned Quadrant Page.

THE

THE

Deſcription of the Diagonal SCALE.

THIS Scale is but ſeveral Lines of Sines, the greater whereof is made equal to the Secant of the Latitude whereto they are fitted, the Radius of which Secant is 5 Inches long.

The leſſer Sines continued the other Way, their reſpective Radius are made equal to the Sine of the Latitude of the greater Sine, whereof they are continued.

The Parallel-Lines fitted to the reſpective Latitude, are not equidiſtant, but are determined by Proportion.

The USE *of the* Diagonal-Scale.

1. *To find the Time of the Sun's Riſing or Setting.*

IN the Parallel proper to the Latitude, take out the Sun's Declination out of the leſſer continued Sines, and enter one Foot of this Extent at the Complement of the Declination of the Line of Sines on the Right Edge of the Quadrant 5 Inches Radius, accounted from the Center; and in the equal Limb, the Thread being laid according to the neareſt Diſtance to the other Foot, ſheweth the Time ſought.

In the Latitude of *York*, 54 deg. if the Sun have 20 deg. Declination

Northwards	he Riſeth at	4	and Sets at	8
Southwards		8		4

2. *To find the Hour of the Day or Night for* South-*Declination.*

In the Parallel proper to the Latitude, account the Declination in the leſſer continued Sine, and the Altitude in the greater Sine, and take their Diſtance, which Extent apply, as before, to the Complement of the Declination in the Line of Sines on the Quadrant 5 Inches Radius, and laying the Thread to the other Foot, according to the neareſt Diſtance, it ſhews the Time ſought in the equal Limb.

Example. In the Latitude of *York*, when the Sun hath 20 deg. of *South* Declination, his Altitude being 5 deg. the Hour from Noon will be found 45 min. paſt 3 in the Afternoon.

For North-*Declination.*

The Declination muſt be taken out of the leſſer Sine in the proper Parallel, and turned upward on the greater Sine, and there it ſhews the Sun's Altitude at 6 of the Clock in this our Northern Hemiſphere, the Diſtance and given Altitude muſt be entered, as before, at the Complement of the Declination, laying the Thread to the other Foot of your Compaſſes according to its neareſt Diſtance; and it ſhews the Hour in the Limb of the Quadrant from 6 towards Noon or Midnight, according as the Sun or Star's Altitude was greater or leſſer than the Altitude at 6.

So in the Latitude of *York*, when the Sun hath 20 deg. of *North* Declination, if his Altitude be 40, the Hour will be 40 min. paſt 8 in the Morning, or 14 min. paſt 3 in the Afternoon.

4. The Converſe of the former Propoſition will be to find the Sun's Altitude at any Hour of the Day, or of any Star at any Hour of the Night.

I need not inſiſt on this, having ſhewn the Manner of it on the foregoing Quadrants, only for theſe Scales, uſe the Limb inſtead of the leſſer Sine; for Stars, the Time of the Night muſt be firſt turned into the Stars Hours, and then the Work is the ſame as for the Sun.

5. *To find the Amplitude of the Sun and Stars.*

Take out the Declination out of the greater Sine, in the Parallel proper to the Latitude, and meaſure it on the Line of the Sines on the Quadrant 5 Inches Radius, and it ſhews the Amplitude ſought

So in the Latitude of *York* 54 deg. when the Sun hath 20 deg. of Declination, his Altitude will be 35 : 35.

6. *To find the Azimuth of the Sun, or any Star in the Hemiſphere.*

For South-*Declination.*

Account the Altitude in the leſſer Sine continued in the proper Parallel, and the Declination in the greater Sine, and take their Diſtance; enter one Foot of this Extent at the Co-ſine of the Altitude, on the formentioned Quadrant, and lay the Thread to the other Foot according to the neareſt Diſtance, and in the Limb it ſheweth the Azimuth from the *Eaſt* or *Weſt* Southward.

So in the Latitude of *York*, when the Sun hath 20 deg. of *South* Declination, his Altitude being 5 deg. the Azimuth will be found to be 44 deg. 47 min. to the Southward of the *Eaſt* or *Weſt*.

For North-*Declination.*

Account the Altitude in the leſſer Sine continued, and apply upwards on the greater Sine, and it finds a Point thereon, from whence take the Diſtance to the Declination in the greater Sine, in the Parallel proper to the Latitude of the Place, and enter one Foot of this Extent at the Co-ſine of the Altitude on the Line of Sines on the Quadrant, and the Thread being laid to the other Foot according to the neareſt Diſtance, ſhews the Azimuth in the Limb from the *Eaſt* or *Weſt*.

So in the Latitude of *York*, when the Sun hath 20 deg. of *North*-Declination, and 40 deg. of Altitude, his Azimuth is 23 deg. 16 min. to the Southward of the *Eaſt* or *Weſt*.

When the Hour, or Azimuth falls near Noon, for more Certainty you may lay the Thread to the Complement of the Declination for the Hour, or the Complement of the Altitude for the Azimuth, in the Limb, and enter the reſpective Extent, Parallelly between the Thread and the Sine; and to find the Anſwer in the Sines.

On the Back-ſide are drawn all theſe Lines.

A large Dialling-Scale of 6 Hours or double Tangents with a Line of Latitude fitted thereto.

A large Chord.

A Line for the Subſtile's Diſtance from the Meridian.

A Line for the Stile's Height.
A Line for the Angle of 12 and 6.
A Line for the Inclination of Meridians.
All theſe relate to Dialling.

An Azimuth Scale being two Lines of natural Sines of the ſame Radius ſet together at O, and from thence numbred with Declination, this Scale muſt be made of the ſame Sine that the Hour-Scale following is made of, continued from O one Way to 38 : 28. and the other Way to 23 : 31 min. or further at Pleaſure: but numbred from the Beginning, which is at the End of that 38 : 28. the Complement of the Latitude with 10, 20, &c. up to 60 deg,

The Hour-Scale is no other than a Line of Sines, with the Declination ſet againſt the Meridian Altitude, in the Latitude of *London*, the Radius of which Sine is equal in Length to the Dialling-Scale of Hours.

The Uſe of theſe Scales.

The Line of Hours and Latitude is general for pricking down all Dials with Centres, as hath already been ſhewed in the Uſe of the great Quadrant, and by the Help of the Scale of Hours may the Diameter of ſuch a Circle be graduated as is placed in on the Back of the Quadrant, and the Line of Latitudes will ſerve as a Chord to divide the upper Quadrant, and the Hour-Scale, or Line of Sines, will ſerve as a Chord to divide a Semicircle (whoſe Diameter is equal to the Scale of Hours) into 90 equal Parts, and their Subdiviſions.

The particular Scales give the Requiſites of upright Decliners in this Latitude by Inſpection, for count the Plane's Declination in the Line of Chords, and a Square laid over it interſects all thoſe Requiſites, or may be found by applying the Declination taken out of the Chords, with Compaſſes to every other Line.

Examp. If an upright Plane decline 35 deg. from the Meridian.

The Subſtile's Diſtance from the Meridian will be	24 : 30
The Stile's Height	30 : 38
The Inclination of Meridians	41 : 49
The Angle of 12 and 6	54 : 10

Theſe particular Scales alſo reſolve ſome of the Caſes of Right-Angled Spherical Triangles, relating to the Motion of the Sun or Stars thus.

Of the Line of the Stile's Height.

Account the Declination of the Star in the Line, and againſt it in the Chord ſtands the Amplitude of the Sun or Star from the Meridian.

Examp. When the Sun hath 18 deg. of Declination, his Amplitude will be 67 : 13 min. from the Meridian, and 29 : 47 from the Vertical.

On the Stile-Line may be found the Sun's Altitude on all Hours, when he is in the Equinoctial, by applying the Hour from 6 taken from the Chords to the other End of the Stile's-Line.

Of the Subſtiler Line.

Hereby we may find the Time of Sun Riſing and Setting, by taking the Declination out of the Subſtiler-Line, and meaſuring it on the Line of Chords.

Examp. When the Sun hath 18 deg. of *North*-Declination, the Aſcenſional-Difference is 24 : 09. in Time 1 Hour 36 ½ min. and ſo much the Sun Riſes and Sets from 6.

Hereby may be alſo found the Equinoctial Altitude to every Azimuth.

Of the Line of the Angle of 12 *and* 6.

Account the Complement of the Declination on this Scale, and againſt it in the Chords ſtands the Hour from Six, that the Sun will be due *Eaſt* or *Weſt*.

Examp. When the Sun hath 18 deg. of *North*-Declination, he will be *Eaſt* or *Weſt* at 7 in the Morning, or 5 in the Afternoon.

By theſe Scales the Requiſites of *Eaſt* or *Weſt* Reclining or Inclining Dials in this Latitude may be fonnd.

1. *The Subſtile's Diſtance from the Meridian.*

Account the Reclination and Inclination in the Chords, and againſt it in the Line for 12 and 6 ſtands the Complement of the Angle ſought.

2. *For the Stile's Height.*

Apply the Reclination in the leſſer Sines on the Diagonal Scale in the Parallel proper to the Latitude to the greater Sine, and it ſhews the Arch ſought.

3. *For the Inclination of the Meridians.*

This may be found alſo on the Diagonal-Scale, when the Subſtile's Diſtance is leſs than the Latitude; by accounting the Subſtile's Diſtance on the greater Sine, and applying it to the leſſer.

4. *For the Angle of* 12 *and* 6.

Account the Complement of the Reclination on the Chord, and againſt it in the Subſtiler-line, is the Complement of the Angle ſought.

If an *Eaſt* or *Weſt*-Dial recline 35 deg.

The Subſtile's Diſtance from the Meridian will be	45 : 52
The Stile's Height	26 : 41
The Inclination of the Meridians	66 : 27
The Angle of 12 and 6.	56 : 55

Of the Hour and Azimuth-Scales.

Theſe Scales are fitted to find the Hour from Noon in the Verſed Sine; and in their Uſe preſuppoſe the Hour and Azimuth of the Sun to be no farther off the Noon Meridian than 60 deg. therefore I think fit to omit it, it being of no great Uſe.

Sect. I. *The Deſcription and Uſe of a Semicircle for this Latitude.*

This Semicircle is an Inſtrument in its Kind, more facile than a Quadrant, there being no Trouble before or after Six in Summer-time, in rectifying the Bead to perform the Operation in the reverted Tail; and the Uſe is eaſy, alſo exact in the Performance, there being no Rule required for rectifying the Bead, but to lay the Thread over the Day of the Month, and to ſet the Bead to that Ecliptick the Thread interſecteth.

This Semicircle hath but one Face.

The Projection being the ſame with that that is firſt deſcribed in the Book, and all the Uſes the ſame. —— The Horizon may be plainly known, it being the biggeſt Line in the Projection, and marked with o —— o —— ſignifying no Degrees of Altitude.

And above the Projection, in two Semicircles, are the Days of the Months, reſpecting the Four Seaſons of the Year.

Alſo in another Semicircle under them is ſet the Sun's Declinatien, to 23 deg. 30m.

Sect. II. *Concerning the Projection for the Latitude of* Barbadoes *and* Greenland, *that is annexed to the Cut of the Semicircle.*

For Variety-Sake there is alſo added a Draught of a Projection for the Latitude of *Barbadoes* and *Greenland:* the Reader may in the Uſe of the former (namely, for *Barbadoes*) find that every Day when the Sun comes to the Meridian between the Zenith and the elevated Pole, he will upon divers Azimuths in the Forenoon (as alſo in the Afternoon) have two ſeveral Altitudes, and ſo be twice before Noon, and twice after Noon, at ſeveral times of the Day upon one and the ſame Azimuth, *viz.* only upon ſuch as lie between the Sun's Coaſt of Riſing and Setting, and his remoteſt Azimuth from the Meridian, which cauſeth the going forwards and backwards of the Shadow; and it may be obſerved, that the Sun for the moſt part in thoſe Latitudes, hath no Vertical Altitude or Depreſſion, and ſo comes not to the *Eaſt* or *Weſt*.

Likewiſe in the latter for *Greenland*, you may obſerve that the Sun, a good Part of the Summer-half-year, comes not to the Horizon, and ſo neither Riſeth nor Setteth.

The Inſtrumental Work of ſome of the foregoing Treatiſe of Mr. *John Collins*, Performed by Artificial Sines and Tangents.

Sect. I. *His greateſt Declination and Place given, to find his preſent Declination.*

Examp. SUppoſe on *April* the 27th, the Sun's Place to be in ♉, 17 : 07, he is diſtant from the neareſt Equinoctial Point ♈ 47 deg. 7 min. his greateſt Declinatiun 23 deg. 30 min. his preſent Declination is required.

Say,

Say, As the Radius	90 : 00	10.00000
Is to the Sine of the Sun's greateſt Declination	23 : 30	9.60070
So is the Sine of the Sun's Diſtance from ♈	47 : 07	9.86495
To the Sine of his preſent Declination	17 : 00	19.46565

Sect. II. *The Sun's greateſt Declination and preſent Declination given, to find his Place.*

Examp. His greateſt Declination 23 : 30. his preſent Declination 17 : 00. *North* increaſing, his Place is required.

As Radius	90 : 00	10.00000
Is to the Sine of the Sun's greateſt Declin. Com. Arith	23 : 30	0.39930
So is the Sine of his preſent Declination	17 : 00	9.46593
To the Sine of the Sun's Diſtance from ♈	47 : 07	9.86523

Sect. III. *The Sun's Declination and Diſtance, from the neareſt Equinoctial-Point given, to find the Right Aſcenſion.*

Examp. As the Radius	90 : 00	10.00000
Is to the Tangent of the Sun's Place, or Diſt. from ♈	47 : 07	10.03211
So is the Co-Sine of the Sun's greateſt Declination	23 : 30	9.96239
To the Tangent of the Sun's Right Aſcenſion	44 : 37	19.99450

Which 44 deg. 37. min. is the Sun's Right Aſcenſion in 17 deg. 07 min. of ♉ : But obſeve, if the Right Aſcenſion of the Point ſought is in the ſecond Quadrant ♋, ♎, ♏, then take the Complement of the Arch found to be 180 deg. if it be in the third Quadrant of Ecliptick, ♎, ♏, ♐, add a Semicircle to the Arch found. But if it be in the laſt Quarter, ſubſtract the Arch found from 360 deg. and you have the Right Aſcenſion deſired.

Sect. IV. *To find the Sun's Amplitude, or Coaſt of Riſing and Setting from the* Eaſt *or* Weſt.

Example. The Elevation of the Pole, and the Declination of the Sun given, to find his Amplitude.

As the Radius	90 : 00	10.00000
Is to the Co-Sine of the Latitude, Complement Arith.	51 : 30	0.20569
So is the Sine of the Declination	17 : 00	9.46593
To the Sine of the Amplitude	28 : 02	9.67162

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